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PURCHASING PATTERNS, CONSUMPTION HABITS, AND PREFERENCES FOR RICE AND CORN [1/]

GLORIA VEGA-YAP AND REMEDIOS O. ALCANTARA

WITH TWO TEXT FIGURES

For every 10 rice-eating households surveyed, 7 purchased their latest supply of rice; among corn-eating households, 8 out of 10 bought corn.

Public markets and sari-sari stores were the two most important sources of rice and corn purchases.

Rice-eating households which bought by the ganta paid on the average ₱1.14 per ganta, whereas those which bought by the cavan paid ₱25.18 per cavan. Corn-eating households paid ₱.53 and ₱13.18 for a ganta and a cavan, respectively.

All households had either rice or corn as staple food for noon and evening meals. For breakfast, staple food varied. It included rice, corn, bread, and root crops. On the average, daily rice and corn consumption per adult equivalent was 211 grams (.17 ganta) and 248 grams (.20 ganta), respectively. Rice and corn consumption is influenced by location, income, size of households, and occupation of major wage earners. Income has the greatest influence. Rice and corn consumption per adult equivalent was highest in barrio households, low income groups, and in households where the major wage earners were engaged in farming. It was lowest in city households, high income groups, and in households whose major wage earners were professionals and managers.

White milled rice and corn from "kiskisan" was preferred by homemakers. They also favored the "pinanitan" type of corn. Low price, good eating quality, and a high degree of expansion are some of the characteristics homemakers look for when buying their staple.

Rice and corn make up an important part of the food consumed by Filipino families. In most places, rice constitutes the principal item in the diet. Corn is used to supplement rice in some parts of Luzon and it is the main food item in some areas of the Visayas and Mindanao. As staple food, rice and corn are of great importance to the economy. In recent years, producers, distributors, and retailers have become increasingly aware of the need

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1/ Central Experiment Station Contribution No. 2076.

for improving the method of marketing rice and corn. To do this a knowledge of purchasing patterns, consumption habits, and consumer preferences is necessary.

The objectives of the study were: (1) to determine the purchasing practices used in obtaining rice and corn, (2) to determine the pattern of rice and corn consumption, (3) to analyze factors influencing the consumption of rice and corn, (4) to study ways in which consumers use rice and corn, and (5) to obtain consumers' preference with regards to rice and corn marketing.

Data in this study were obtained from personal interviews of 3,576 households. The number of towns, barrios, and cities and the number of households surveyed from a municipality or city were obtained by judgement sampling. Table 1 shows the distribution of the households.

TABLE 1.—*Distribution of schedule*

REGION	LOCATION			
	City	Poblacion	Barrio	All Areas
	number			
Metropolitan Manila	538	—	—	538
Ilocos	—	36	204	240
Cagayan Valley	—	62	60	122
Central Luzon	38	12	205	255
Southern Luzon	—	173	825	998
Bicol	15	161	398	574
Western Visayas	—	13	112	125
Eastern Visayas	258	10	118	386
Southwestern Mindanao	—	125	—	125
Northwestern Mindanao	85	—	128	213
TOTAL	934	592	2050	3576

Because of variations in the households, it was necessary to measure consumption in terms of adult equivalent. The food consumed by each household was put on such a basis that the amount could be compared with that used by another. That is, a child of three years is considered as consuming the quivalent of 0.5 or one-half of an adult of 15 years or more in age. The following scale was used to determine the adult equivalents of all members of the

household.[2/]

Age in years (both sexes)	*Adult equivalent*
less than 1	0
1 — 4	.50
5 — 9	.70
10 — 14	.85
15 and above	1.00

Findings in this study are concerned with three areas of the overall marketing problem of two major farm products, rice and corn. These areas are purchasing patterns, consumption habits, and preferences for rice and corn. The survey included households with rice and/or corn as principal item(s) in their meal. But in the analysis and discussion of the three phases of study, not all records were included. For instance, only households which had one staple food — either rice or corn — were included in the discussion of consumption habits. However, with the two other phases, households with two staple foods—rice and corn—were included in the analysis.

The first part of the discussion will be concentrated on the purchasing patterns, consumption habits, and preferences for rice.

RICE PURCHASING PATTERN

The choices made by consumers in their purchases of rice have a direct bearing on the price of rice and indirectly on the farmers in the area who produce rice for sale. The price system *per se* does not tell the producer or marketing agency how to market the products but only the extent of the demand for the product. It is essential therefore that farmers know the desires as well as the purchasing patterns of the final buyers of their products for an efficient production and marketing program. In this phase of the study, only rice-eating households were included in the analysis.

Source of last supply. In all regions of the Philippines, homemakers may purchase their rice from many sources. By asking the

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/2 In the course of the study, the authors have become more and more convinced that the assumptions on adult equivalent are not entirely realistic when it comes to rice consumption. For instance, a child in the age bracket 1—4 is not likely to consume half as much rice as an adult.

homemakers where they got their latest supply of rice, it was found that for every 10 households surveyed, 7 purchased it. It is interesting to note that those who bought rice were not only non-farmers but also farmers who did not produce enough for one year's consumption.

Findings of Gapud (1959) [3/] in Muñoz, Nueva Ecija showed that 95 per cent of farmers' loans were used for subsistance which above all included rice purchases.

Rice used by 25 per cent of the households included in the study was produced on the farm by the husband, son, or tenants. Some laborers and barbers, constituting three per cent of those surveyed, received their supply as payment for services rendered. Others obtained theirs through barter, or as a gift from relatives.

The highest percentage of rice purchases was found in Manila and Eastern Visayas where most wage earners had office jobs. Among Manila households, only landowners did not buy rice. In Cebu City where corn was found to be the staple food, most rice-eating households surveyed purchased rice. Eighty-eight per cent of the households in the city purchased rice (table 2).

TABLE 2.—*Source of last supply of rice by location,* 3228 *households*

SOURCE	HOUSEHOLD			
	City	Poblacion	Barrio	All Areas
		per cent		
Bought	88	64	66	71
Own production	11	32	29	25
Others	1	4	5	4
TOTAL	100	100	100	100

Slightly more of the households in the *poblacion* than in the barrios got their latest supply of rice from their own farms as the enumerators met more landlords in the poblacion. On the other hand, there were slightly more barrio households who purchased their latest supply of rice than *poblacion* households because tenants either did not produce enough for one year's consumption or had to sell part of their share during harvest season to pay for their

3/ J. P. Gapud, Financing farming in selected barrios of Gapan, Nueva Ecija, 1957-1958. Economics Research Journal. Vol. 8, No. 2 (1959).

other needs. This left them no alternative except to buy during off-season months when the price of rice is high.

Sources of rice purchases. There are many channels through which rice can pass in moving from the producer to the final consumer. It can go through several hands before the final sale.

A knowledge of the final outlet and the homemaker's source of purchase is important. Once a consumer decides on a specific place from which to purchase her rice, she tends to buy most of her other needs from that source.

Two important sources of rice are the public markets [4/] and sari-sari stores. [5/] Nearly half of the homemakers bought their rice from public markets. They said that doing so saves time and money as the market provides them with almost all their needs. However, they noted one limitation of a public market: few of its stores extend credit, a service rendered by most of the sari-sari stores. Forty per cent of the homemakers bought from sari-sari stores (table 3).

TABLE 3.—*Source of rice purchases by location, 2304 households*

SOURCE OF SUPPLY	LOCATION			
	City	Poblacion	Barrio	All Areas
		per cent		
Public markets	42	50	46	46
Sari-sari stores	36	34	43	40
Naric stores	18	5	4	8
Rice mills	a/	6	5	4
Farmers	2	2	1	1
Others	2	3	1	1
TOTAL	100	100	100	100

4/ Areas or places set up by the government of the city, town, or larger barrio where the public may buy and sell its goods. All types of retailers may be found in this market.

5/ Retail stores which handle only a small number of non-perishable items and which are scattered throughout the city, town, or barrio.

Form of product last purchased. Almost all of 98 percent of the households bought milled rice, and only 2 per cent purchased palay. Not one of the city households bought rice in palay form. The greater preference for milled rice is due to its readiness for immediate use.

Size and unit of last purchase. Households surveyed purchased rice in different units. More than three-fourths of them bought rice by the ganta (fig. 1). Twenty-one per cent bought by the

Fig. 1.—*Homemakers usually purchase rice by the ganta.*

cavan (table 4).

Nearly one-third of the households surveyed purchased rice on a weekly basis; the average amount of rice last purchased was almost 5 gantas. Households buying by the ganta purchased 4.6 gantas and those buying by the cavan purchased, on the average, 1.3 cavans.

Difference in the size of purchase in the various locations may be attributed to the distance separating the barrio and the purchase source. Since public markets are usually found in cities and *poblacion,* homemakers in the barrios tended to buy larger quantities per purchase to save in transportation expenses. However, there were cases where homemakers walked several kilometers everyday to buy rice. The enumerators, for example, found some

TABLE 4.—*Size of purchase of milled rice by location, 2212 households* */

SIZE OF PURCHASE	LOCATION			
	City	Poblacion	Barrio	All Areas
Ganta		*per cent*		
Below 5	76	78	73	
6—10	17	18	22	
11 & above	7	4	5	
Total	100	100	100	
Average size of purchase	4.4	4.3	4.7	4.6
Cavan				
Below 1.5	89	85	81	
1.5—3	8	13	17	
3.5 & above	3	2	2	
Total	100	100	100	
Average size of purchase	1.2	1.0	1.4	1.3

homemakers in the barrios of Cabanatuan City who walked 13 kilometers everyday to buy a ganta of rice in a public market. This was resorted to partly because of irregular and insufficient cash income among households and partly because of improper money management.

Classes of rice used. Rice varieties were classified by the Plant Breeding Division of the U.P. College of Agriculture as good, fair, or poor according to the eating quality. Some varieties could not be classified and were dropped from the list for the purpose of this analysis. Household income per adult equivalent influenced the class of rice bought. The bigger the income, the higher was the percentage of households purchasing good quality rice (table 5). In all regions covered in the survey, poor quality rice was used by a relatively few households. It was not used by the highest income group of households in the city and *poblacion.* However, it was used by the highest income group among the barrio households.

Price of milled rice per unit of purchase. The price paid for different classes of rice did not vary greatly. Rice classified as good in eating quality had a higher price than that classified as fair or poor. Good quality rice, mostly Wagwag and American rice, cost ₱1.20 a ganta whereas the fair and poor varieties sold at ₱1.09 a ganta. Fair varieties included Macan and Ordinario, and poor, Thailand and Inintiw.

Those who bought rice by the cavan paid ₱27.46 per cavan for good quality rice. For fair and poor varieties, households paid

TABLE 5.—*Class of rice used by household income by location, 2532 households*

INCOME CLASS	CLASS OF RICE			
	Good	Fair	Poor	All Classes
	per cent			
City				
99 & below	41	56	3	100
100 — 999	58	42	—	100
1000 & above	70	30	—	100
Poblacion				
99 & below	58	42	—	100
100 — 999	75	23	2	100
1000 & above	88	12	—	100
Barrio				
99 & below	43	53	4	100
100 — 999	58	36	6	100
1000 & above	81	16	3	100
All areas				
99 & below	44	52	4	100
100 — 999	62	35	3	100
1000 & above	74	25	1	100
All groups	59	38	3	100

a/ Four hundred and thirty households purchased rice which could not be classified by the Division of Plant Breeding, 46 households bought rice by the liter and chupa and 46 households bought rice in palay form.

₱25.89 and ₱19.83 a cavan, respectively. On the average, a cavan of rice cost ₱25.81.

It is generally assumed that the larger the quantity purchased, the less cost per unit. In all areas surveyed, buying rice by the cavan was slightly cheaper than buying in small quantities.

Households which bought by the ganta paid on the average ₱1.14 whereas those which bought by the cavan paid ₱25.81 (table 6).

TABLE 6.—*Price of milled rice per unit of purchase by class of rice, 1782 households a/*

CLASS OF RICE	AVERAGE PRICE OF MILLED RICE PER UNIT OF PURCHASE	
	Ganta	Cavan
	pesos	
Good	1.20	27.46
Fair	1.09	25.89
Poor	1.09	19.83
All Classes	1.14	25.81

a/ Six hundred and forty-seven households used rice unclassified by the Plant Breeding Division and 49 households refused to give their income.

If a cavan is taken to contain 25 gantas, this will mean that the cost of a cavan is ₱28.50. There is, therefore, a saving of ₱2.69. Besides, it should also be considered that the typical ganta of rice sold in retail is often short of being full as a result of a practice usually followed whereby the ganta is filled in a slanted rather than in a level position. For instance, Darrah and Cruz (1958)[6/] found that for every cavan of 25 gantas purchased, a retailer sold 26 gantas. This method of selling should encourage consumers to buy rice in big quantities. Although the amount that can be saved by wholesale purchase varies with the type of product that is bought, price comparisons should be made in order to determine if savings are possible.

Schedule of buying. Homemakers surveyed bought relatively small quantities of rice. Weekly rice purchase was followed by 33 per cent of the homemakers interviewed in the barrio, 28 per cent in the city, and 22 per cent in the poblacion (table 7). These home-

TABLE 7.—*Schedule of buying rice by location, 2304 households*

SCHEDULE	HOUSEHOLD			
	City	Poblacion	Barrio	All Areas
			per cent	
Daily	17	15	12	14
Twice or thrice a week	19	21	20	20
Weekly	28	22	33	30
Twice or thrice a month	16	13	13	14
Monthly or less often	20	29	22	22
TOTAL	100	100	100	100

makers claimed that this was the best schedule of buying rice because they did not have to go the public market very often.

Among the households surveyed, the size of purchase and the frequency with which it was done were affected by the distance of the source of purchase from the house. City homemakers negotiated an average of 2 kilometers, and poblacion households an aver-

6/ L. B. Darrah, "Marketing Farm Products in the Philippines (1958)."

age of 4 to 5 kilometers, in buying rice in public markets and sari-sari stores.

Type of container for rice. Fifty-five per cent or more than one-half of the households used paper bags. As previously noted 77 per cent of the households purchased rice by the ganta. Gunny sacks were commonly used by those who purchased rice by the cavan.

In places where rice was the only commodity sold, as in NARIC stores, rice mills, and rice farms, buyers usually provided their own containers. Thirty-six per cent of those who bought rice in public markets, 41 per cent in sari-sari stores, and 23 per cent in NARIC stores, rice mills, from farmers, and others supplied their own containers.

Manner of payment. In all areas surveyed, 90 per cent of the rice buyers paid in cash and 10 per cent bought on credit. The number of household creditors was greater in the barrios than in any other area. Income showed no relationship to the manner of payment of rice purchased.

RICE CONSUMPTION

Food is the major item of expenditure among families in the Philippines. Based on 1955 data, 48 per cent of the average consumer expenditure was for food [7/]. This is approximately twice the proportion spent for food in the United States.

Rice as staple food [8/]. The frequency with which rice is served is an important determinant of the level of consumption. All the 2979 rice-eating households surveyed had rice as staple food for their noon and evening meals. For breakfast, slightly more than one-half of all rice-eating areas surveyed had rice as the main staple (table 8). If households who had bread and rice for breakfast

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7/ J. L. Cook, Dimas Maulit and Jose Lewas, long range requirements for selected foods in the Philippines. Special reports by ICA and DANR (1957.)

8/ Staple food as used here refers to the principal food item in the needs of the households.

TABLE 8.—*Staple food used for breakfast, by location, 2978 households*

STAPLE FOOD	HOUSEHOLD			
	City	Poblacion	Barrio	All Areas
		per cent		
Rice	22	55	64	53
Bread	55	20	16	26
Rice and bread	22	24	15	18
Others	a/	1	5	3
TOTAL	100	100	100	100

were included, 70 per cent will fall under this category. Table 8 shows that three per cent—mostly barrio households—had bananas, corn, and root crops for breakfast. A few households had *puto* or *bibingka* which are special products made of rice. *Puto* or *bibingka* was frequently served during meal or snacks times.

A survey concluded that the meals of the rural folks are invariably high in carbohydrates, but low in protein, sugar, fats, and vitamins.[9/]

Bread without rice was used by more than half of the city households and by one-fifth of the *poblacion* households. But in the barrio households, only 16 per cent had it for breakfast. This discrepancy may be explained by the fact that the consumption of bread is confined largely to urban areas, owing to the lack, and the inadequacy of the distribution system of bakeries in the rural areas. Another reason could be income. Cash income is higher in urban than in rural areas. Since urban households have to purchase both rice and bread, most of them consider the latter alone for breakfast as less expensive. A common practice is to dip bread in such morning beverages as coffee and chocolate.

Less than one per cent of the city households skipped breakfast. These households were from the squatter areas in Manila and Cebu. The head and/or children of the families in these areas were usually seeking employment in the city. When these families who had nothing to eat for breakfast were asked what they had the day before the survey they answered, "memorized". This meant that they did not eat anything.

Consumption figures in this study were obtained by asking the amount of rice consumed the day before the survey. This amount

9/ G. F. Rivera and R. T. McMillan, the Rural Philippines. Reproduced by the Office of Information, Mutual Security Agency, Manila, Philippines (1952).

varied, with many factors accounting for the differences. Among these factors were location, income, size of households and occupation of husband or major wage-earners. Excluded was the generally accepted idea that consumption of grain products varies with temperature changes, that is, rice consumpion rises in cool weather and declines in warm weather.

Some Factors Affecting Rice Consumption

Location

The location of consumers influences their consumption of food. Different areas are not equally devoted to the production of the same products. Consumption is affected by what are available in the area.

In this study, it was noted that households surveyed in Western Visayas, the Ilocos region, and Central Luzon were among the highest rice consumers. The lowest rice consumers were found in Eastern Visayas and metropolitan Manila (table 9). Corn is the staple

TABLE 9.—*Daily rice consumption per adult equivalent by region, by location, 2979 households*

REGION	LOCATION			
	City	Poblacion	Barrio	All Areas
		grams		
Metropolitan Manila	161	—	—	161
Ilocos	—	223	285	273
Cagayan	—	198	136	186
Central Luzon	223	198	273	260
Southern Luzon	—	174	236	223
Bicol	174	186	211	198
Western Visayas	—	347	322	322
Eastern Visayas	161	—	260	161
Southwestern Mindanao	—	248	—	248
Northwestern Mindanao	174	—	223	198
ALL REGIONS	174	198	236	211

crop in Cebu. In Manila, rice is supplemented with bread either

during breakfast or snack time.

Of the different locations in the regions surveyed rice consumption was highest among barrio households except in Cagayan and Western Visayas. The exception in Cagayan was probably due to the competition posed by corn, plus the fact that the previous year was a poor (rice) crop year.

The high rice consumption rate among most barrio households could be attributed to the nature of occupation of their wage earners. The majority of households in the barrios are farm households and most members are part of the farm labor force. The big energy requirements among farm laborers make them relatively heavy cereal eaters.

Rice consumption was least among city households, except in Cabanatuan City in Central Luzon. In Cabanatuan, rice fields could still be found within city limits. Unlike other cities, many major wage-earners in Cabanatuan were found to be engaged in farm jobs or occupations requiring physical activity.

Daily rice consumption per adult equivalent, by location, by meals. Daily rice consumption per adult equivalent for all regions surveyed was 211 grams (table 10). In terms of weekly ganta

TABLE 10.—*Daily rice consumption per adult equivalent by location, by meals, 2979 households*

LOCATION	RICE CONSUMPTION PER ADULT EQUIVALENT			
	Breakfast	Lunch	Supper	All Meals
	grams			
City	25	74	74	174
Poblacion	37	87	74	198
Barrio	62	87	87	236
ALL AREAS	37	87	87	211

consumption, it was 1.19 ganta per adult equivalent. Compared with other studies, the daily rice consumption per adult equivalent obtained in this study is relatively low. Dalisay [10/] reported a na-

10/ Armando M. Dalisay, "The Rice Problem and Price Support Policy." (Paper presented during the Agricultural Economics Seminar, College of Agriculture, U.P., November, (1955).

tional daily rice consumption per capita of 292 grams.

City households had the least daily consumption of rice, which was 174 grams. Households in the *poblacion* and barrio had 198 and 236 grams, respectively.

For either the noon or evening meal, rice consumption per adult equivalent was 74 and 87 grams for barrio and city households, respectively. Among the households in the *poblacion,* rice consumption was 87 grams for noon meals, and 74 grams for evening meals.

As was previously noted, rice was least consumed during breakfast especially among the households in the city and *poblacion* because bread was used either as the staple food or as a supplement.

Size of Households

Rice consumption per adult equivalent decreased with the increase in the size of the household. In this study, households with 1 to 5 members reported a consumption of 248 grams per adult equivalent, while those with 6 — 10 and 11 members and more, had 211 and 174 grams, respectively.

As expected, rice consumption per household increased with the increase in the size of household. But the rice consumption per adult equivalent decreased with the increase in the size of household. This is due to the presence of more children below 15 years of age in large than in small households. In general, children do not eat much during regular meal times because they frequently partake of snacks.

According to Brunk and Darrah, in large families the money spent for food for each person is less than that spent in small families.[11/] They attributed this to two factors. First, children require less food energy and nutrients than adults and therefore need less food. Second, the per capita income is higher in small families than it is in large ones with the same total amount to spend.

Another factor which will help explain the decrease in the rice consumption per adult equivalent with the increase in the size of household is household income. Household income per adult equivalent decreased with the increase in the size of household. Households with large members and who had small household income per adult equivalent used substitutes such as cassava, camote, and banana.

11/ Max E. Brunk and L. B. Darrah, Marketing of Agricultural Products, the Ronald Press Co., New York, (1955).

It is evident in table 11 that within an income group, rice consumption per adult equivalent tended to decrease with an increase in the size of household.

TABLE 11.—*Daily rice consumption per adult equivalent by household income per adult equivalent by size of households, 2979 households*

SIZE OF HOUSEHOLD	HOUSEHOLD INCOME PER ADULT EQUIVALENT			
	99 & below	100-999	1000 & above	Total
	grams			
1 — 5	273	236	223	248
6 — 10	236	211	161	211
11 & above	223	174	161	174
TOTAL	248	211	186	211

Rice consumption per adult equivalent decreased as the size of households with an income of less than ₱1000 per adult equivalent increased. Among households with an income of ₱100 and more, consumptoin of rice decreased but tended to remain the same as the size of the households increased. Among big households with low income, food equipment comes from cheap sources. In most cases, rice takes a big portion of the meal (fig. 2). The following conclusions were drawn in the Bicol and Central Luzon dietary survey: "Total calorie intake was a little short of adequate and distribution of calories was defective, there being too much carbohydrates and too little fat in the diet. [12/]

Income

The most important factor affecting consumption of farm products is income.

In this study, households with an income of ₱1000 or more per adult equivalent had a daily rice consumption of 186 grams whereas those with less than ₱1000 per adult equivalent consumed 248 grams

12/ Nutrition Survey of 189 Households in Two Regions of the Philippines, (1957).

Fig. 2. — *Rice comprises a big portion of the regular meals of the majority of barrio families.*

(table 12). This, to some extent, is a reflection of the income elas-

Table 12.—*Daily rice consumption per adult equivalent by household income, per adult equivalent by location,* 2979 *households*

LOCATION	HOUSEHOLD INCOME PER ADULT EQUIVALENT			
	99 & below	100-999	1000 & above	Total
City	174	174	161	174
Poblacion	248	198	198	198
Barrio	248	236	198	236
ALL AREAS	248	211	186	211

ticities of different products. Rice has an income elasticity of .12 which means that demand of rice is quite inelastic. [13/] Among high income groups, products with low income elasticities become relatively more important. On the other hand, products with high income elasticities are relatively more important among high income

13/ Brunk and Darrah, Op. cit.

families. Items like meat, eggs, bananas and the like are of higher proportion in their food expenditure than the low income group. Low income households consume more of rice or of the staple food. It was observed that low income households have poor diets. Furthermore, high income families can afford snacks or in-between meals, a practice which tends to lower their rice consumption during meal time.

In all the different income groups, city households surveyed had the least rice consumption per adult equivalent. In the cities where cash income was highest, a high percentage of households ate bread for breakfast.

Occupation

The occupation of the consumer has some influence on the consumption of rice. Those who are in occupations that demand more food energy usually eat more rice than those whose jobs require less physical activity. Rice consumption per adult equivalent among farmer groups was at 248 grams, one of the highest. Greater energy requirements make farmer groups relatively heavy rice consumers.

Rice-eating farmers usually depend mainly on farming for their existence. They are therefore generally poor and cannot afford to buy to any considerable extent food to supplement their staple cereal. Furthermore, because of their poverty, these farmers are forced to sell their other produce like vegetbles, fruits, eggs, etc., of which they are themselves in need, in order to be able to meet other essential expenditure.

Another heavy rice consumer is the non-sedentary group of manual workers (table 13). Households of these workers had a daily rice consumption of 236 grams per adult equivalent. Rice consumption was least among the households of professionals, administrators, clerical workers, and others whose jobs were non-sedentary. They had a daily rice consumption of only 174 grams per adult equivalent, most probably because their jobs did not require much physical activity.

The daily rice consumption per adult equivalent averaged 198 grams among the sedentary occupational groups, and 236 grams among the non-sedentary groups. Among the highest income group of households with major wage-earners in sedentary occupations the daily rice consumption was 174 grams whereas among the lowest income groups, it was 236 grams. Rice consumption was 248

TABLE 13.—*Daily rice consumption per adult equivalent by household income per adult equivalent by type of occupation of wage-earner, 2979 households.*

TYPE OF OCCUPATION OF WAGE-EARNER	HOUSEHOLD INCOME PER ADULT EQUIVALENT			
	99 & below	100-999	1000 & above	Total
Sedentary				
Professional, technical and related workers	174	174	149	174
Proprietors, managers, administrators and officials	260	174	161	174
Clerical, office and related workers	198	174	174	174
Workers in operating transport occupation	236	198	174	198
Salesmen and related workers	236	198	236	211
Others — pensionados, gamblers, and money lenders	285	198	260	211
T o t a l	236	198	174	198
Non-sedentary				
Service and related occupation	248	211	236	211
Craftsmen, factory operatives and workers of related occupation ...	236	211	211	211
Workers in mine, quarry and related occupation	—	223	124	211
Manual workers and laborers	248	236	236	236
Farmers, farm laborer, fishermen and related workers	248	248	223	248
T o t a l	248	236	211	236
GRAND TOTAL	248	211	186	211

grams and 211 grams for the lowest and highest income groups of households, respectively, with major wage-earners in non-sedentary occupations.

Income difference within an occupational group influences rice consumption to some extent. Rice consumption tended to be lower among high income groups than among low income groups, except among salesman, service and related workers (table 13).

Rice Substitutes

One-half of the households surveyed ran short of rice. Slightly more than one-fourth of them did not use any substitute. They either borrowed or bought rice on credit.

Seventy-three per cent of the households used substitutes such as corn, banana, bread, and root crops.

A total of 740 households reported that during periods of low rice supply , they mixed rice with other foods. Nearly three-fourths of them mixed rice with corn. Other foods used to mix with rice were cassava, camote, and banana, The proportion of rice to corn used varied. Forty-three per cent of the households used 1 part rice and 1 part corn. More than one-third used 1 part rice and 5 parts corn.

Reasons given for mixing rice with other food varied too. But the majority, 83 per cent, said it was cheaper than eating rice alone. Non-Cebuanos temporarily staying in Cebu mixed rice with corn because corn is "too heavy" in the children's stomach. Other reasons given were palatability, nutritious value, and preference by old folks.

HOMEMAKERS' PREFERENCES

Preferences for rice among homemakers should be determined to be able to guide those engaged in rice marketing. Preferences affect demand by influencing the proportion of income which consumers will be willing to spend for a commodity. But consumer differences differ. What determines these differences? Some are undoubtly the effects of regional production patterns. Whatever the cause, however, such preferences must be recognized by the marketing agencies in getting the right things to the right places. By this, producers would be able to understand the demands of the prospective users of their products, and middlemen and retailers would also know more on how much consumers would be willing to pay for the goods.

Method of milling preferred. Two-fifths of the homemakers interviewed preferred rice milled from "kiskisan." Although it is not

common to find pounded rice on sale in stores, 35 per cent indicated their preference for it, saying that it had a high vitamin B content and was palatable. Nearly one-half of the city homemakers studied preferred pounded rice. This may be explained by the fact that city people, being better educated, are more aware of the merits of this rice. For one thing, many grade and high schools emphasize that pounded rice is more nutritious than milled rice.

Form of product preferred. Ninety-two per cent of all households surveyed preferred milled rice to palay. Their reasons were that milled rice is ready for cooking, is easily secured, and can be bought in small quantities. Also, it eliminates extra milling expenses. Regarding their preference for the kind of milled rice, 72 per cent of the homemakers favored rice in its polished form, and 27 per cent in its unpolished form. The latters' partiality to unpolished rice was, according to them, due to its vitamin content. Only 2 per cent preferred pre-mixed rice, because few homemakers recognized it.

Only 7 per cent preferred to buy rice in the form of rough palay. These homemakers said that this type was cheaper, and they could use the rice bran for feeding pigs, washing dishes, and as fuel. Also, they could choose the method of processing it. Many prefer having this done in "kiskisan" mills as it is a lot cheaper.

Type of display preferred. Darrah and Cruz noted in their survey that the usual practice is to display rice in open bins near or in front of the store or stall. [4/] Occasionally, retailers may be found displaying it in flat trays on the floor. In a few stores, attempts are made to cover the display to prevent dust, dirt, insects, rodents, and other foreign matters from getting into the rice.

Sixty per cent of all homemakers surveyed preferred to buy rice in closed containers as it is free from dust, dirt, and other foreign matters. More than one-fourth preferred open containers. These homemakers said that in open containers, the variety, color, and texture of the rice could be detected at a glance. Half-closed containers were preferred by only 7 per cent. Two per cent did not have any preference.

Like the open bins, prepacking was not well accepted by the homemakers: only one-fifth favored it. Contrary to what was expected, those who wanted prepackaged rice came from either the

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14/ Darrah and Cruz, Op. cit.

poblacion or the barrio. More than three-fourths, most of them from the city households, expressed a dislike for prepacking. They said that the retailers might cheat them by packaging rice of inferior quality, or by placing less than the quantity asked for. This finding is contrary to what Darrah and Cruz found in their study, that is, prepackaged rice is widely accepted by rice buyers. [15/] To be accepted, it seems that both consumers and retailers have to be made aware of the merits of this marketing practice through education.

Class of rice preferred. To obtain information on rice preferences and to determine whether homemakers could recognize the quality of rice or not, four samples of rice were shown to the homemakers. These four varieties were: BE3 fancy varieties, Wagwag for special, Palawan for ordinary, and Thailand for inferior quality. More than half of the homemakers chose Wagwag, claiming that it is a good quality rice and therefore could be eaten with not-so-good viands. The fancy variety was selected by about 25 per cent of the homemakers in the barrios and *poblacion*, and by 31 per cent of those in the city. Homemakers who preferred the ordinary and inferior varities pointed out that these varieties expand more than the two other varieties when cooked.

Generally, most households in all survey areas preferred rice having good and fair eating quality.

When asked for some criteria used in identifying rice of good quality, the homemakers placed great emphasis on the degree of expansion. The chalky characteristic of the ordinary and inferior varieties, they said, is a sign of a low degree of expansion. Factors such as the size and shape of the rice, and the length of storage were also given.

Many homemakers determine the quality of the rice they purchase through its price: if the price is high, the quality of the rice is good, and vice versa. Thus, it has been observed that some consumers buy rice by saying, "Will you give me the ₱1.00-a-ganta rice?"

Color of rice preferred. Slightly more than four-fifths of the rice-eating households surveyed preferred white rice for their regular meals. This stresses one belief of consumers which affects rice consumption: households use white rice because they take the white

15/ Ibid.

color as a sign of quality and palatability. Furthermore, they argue that with white rice, the viand need not be very good. Some considered eating non-white rice degrading.

Impurities observed in last rice rice purchase. Eighty-two per cent of the households found impurities in their rice, the most objectionable of which were grit, weed seeds, and palay. These impurities were mixed with the rice somewhere along the marketing channel.

The presence of grit could be attributed to improper drying, such as when the drying lots are not thoroughly cleaned. Stones are mixed with the palay and are not removed during the process of milling. The presence of palay could be due to insufficient milling. Other impurities found, though rare, were manure especially that of the cockroach, and mongo beans.

CORN PURCHASING PATTERN

Corn ranks next to rice as a staple crop in the Philippines. It is produced to meet the demands of the corn-eating population which makes up about 20 per cent of the people in these islands [16/], and of industries that use corn for brewing and in the manufacture of corn starch and poultry feeds. When the rice harvest is poor, corn is usually used as a substitute for rice. In districts where there is a shortage of rice, corn is often mixed with it. Thus, the efficient marketing of corn is important from the standpoint of both the farmers and the consumers.

This phase of the study covers information concerning the purchasing pattern, uses of and substitutes for corn, and preferences of 343 corn-eating households from six places, namely, Tuguegarao, Cagayan; Cebu City; Tuburan, Cebu; Butuan City; Marbel, Cotabato; and Ozamis City.

Sources of last supply. Eighty-three per cent of the 343 households surveyed purchased their latest supply of the commodity, 16 per cent produced it on the farm, and the rest obtained it as payment for money lent, through barter, or as a gift from relatives and friends. (Table 14).

Source of last purchase. Public markets were the most important source of corn purchases. Ninety-five per cent of the house-

TABLE 14.—*Source of last supply, 343 households.*

SOURCE OF LAST SUPPLY	PLACE			
	Cagayan	Cebu	Mindanao	All Places
	per cent			
Bought	68	93	70	83
Own production	32	6	27	16
Others	—	1	3	1
TOTAL	100	100	100	100

holds from Cagayan and about two-thirds of the households from Cebu and Mindanao purchased corn from public markets (table 15).

TABLE 15.—*Sources of last purchase, 285 households*

SOURCE OF LAST PURCHASE	PLACE			
	Cagayan	Cebu	Mindanao	All Places
	per cent			
Public markets	95	64	68	69
Sari-sari stores	5	34	19	27
Others	—	2	13	4
TOTAL	100	100	100	100

As with rice, the public market was preferred because it enabled the homemakers to buy their other needs like meat, fish, and vegetables without incurring additional transportation expenses and wasting time. Also, in the market, the barrio people were able to simultaneously sell their farm produce and do their household marketing. Furthermore, market stores sold corn at a price 5 to 10 centavos cheaper than sari-sari stores.

Form of products and varieties used. Of the households that purchased corn, almost all or 98 per cent bought it in milled form. The remaining 2 per cent purchased grain corn.

Ninety-five per cent of the households purchased the white variety. Most of the homemakers considered this variety as the "eating variety" and the yellow varieties as feeds for livestock and poultry.

Regardless of the cash income per capita, most households bought the white variety of corn for consumption.

Size of purchase and price per ganta. Homemakers bought corn in small quantities, and hence, frequently. Regardless of the size of households, most purchases were done weekly or oftener. The most common unit of purchase was the ganta. Homemakers who purchased by the ganta bought an average of a little less than 5 gantas within a week, and those by the cavan, an average of one cavan. Of the 285 households who purchased corn, 13 per cent bought by the cavan, 84 per cent bought by the ganta, and the rest by the chupa or liter.

The price of milled corn averaged ₱0.53 per ganta and ₱13.18 per cavan.

Container preferred. Paper or cello bags were used by slightly more than one-half of the households surveyd. Twenty-eight per cent used sacks. The rest used cloth and buri bags, and cans.

The containers used were either supplied by the sellers, or were brought along by the buyers. The former furnished 53 per cent of the containers used. The rest were taken care of by the buyers.

Manner of payment. Buying on a cash basis was the common practice in all areas studied. Only 11 per cent of all households surveyed bought their latest supply of corn on credit. No relationship existed between income and the manner of payment of corn.

CORN CONSUMPTION

Corn as a staple food. No other staple food was used in the noon and evening meals except corn. For breakfast, more than one-half of the households used corn, and the rest used bread, fruits, and root crops (table 16).

TABLE 16.—*Staple food for breakfast,* 343 *households*

STAPLE FOOD	PLACE			
	Cagayan	Cebu	Mindanao	All Places
	per cent			
Corn	88	69	89	78
Bread	3	16	6	11
Corn and bread	9	14	3	10
Fruits and root crops	—	1	2	1
TOTAL	100	100	100	100

Most households used white corn called "pinanitan." [17/] It was generally believed that "pinanitan" corn is palatable and does not need to be eaten with good viands.

Daily corn consumption per adult equivalent. Daily corn consumption ranged from 223 grams to 260 grams per adult equivalent. In terms of weekly ganta consumption, it was 1.4 ganta per adult equivalent.

In all corn-eating households surveyed, the average daily corn consumption for breakfast was 74 grams per adult equivalent. The average consumption for either lunch or supper was 87 grams per adult equivalent (table 17).

TABLE 17.—*Daily corn consumption per adult equivalent by meals, 343 households*

PLACE	DAILY CORN CONSUMPTION PER ADULT EQUIVALENT			
	Breakfast	Lunch	Supper	All Meals
Cagayan	74	99	87	260
Cebu	74	87	99	260
Mindanao	74	74	74	223
ALL AREAS	74	87	87	248

Some Factors Affecting Corn Consumption

Location

Corn consumption was highest among barrio households, which reported a per adult equivalent of 270 grams as compared with 186 and 211 grams for the *poblacion* and city households, respectively. This could be attributed to the nature of occupation of majority of the wage earners in the barrios. Most of them were farmers, the work of whom is mostly physical. Differences in income was also, to a great extent, an influencing factor.

17/ Milled or ground corn whose outer covering or skin is removed through the milling process.

Size of household

Household consumption increased with the increase in the number of persons in the household. However, the consumption per adult equivalent decreased as the size of the household increased. Part of this decrease is explained by the lower income per household in large households.

The daily corn consumption per adult equivalent in Cagayan and Cebu was 260 grams and in Mindanao, 223 grams. (table 18).

TABLE 18.—*Daily corn consumption per adult equivalent by size of household, 343 households*

PLACE	SIZE OF HOUSEHOLD			
	1-4	5-8	9 & above	Total
	grams			
Cagayan	372	273	198	260
Cebu	310	260	223	260
Mindanao	360	248	186	223
ALL AREAS	310	260	211	248

These are higher than the 6 cavans per capita annual consumption reported in another study. [18/]

Income

Corn was found to be the staple food among both high and law income households. In Cebu, for example, enumerators found out that even prominent families had corn as their principal food item. Non-Cebuanos ate rice but gave corn to the household helpers.

The amount of rice consumed per adult equivalent per day tended to decrease as the household income per adult equivalent increased. (table 19). Households with high income could afford to buy more meat, vegetables, fruits, bread, and other products and this accounted for their low corn consumption.

18/ Corn Production in the Philippines. A Student Manual for use in Vocational Agriculture. Prepared by the U.P. College of Agriculture, 1960.

TABLE 19.—*Daily corn consumption per adult equivalent by household income per adult equivalent, 343 households*

PLACE	HOUSEHOLD INCOME PER ADULT EQUIVALENT			
	₱49 & below	₱50-299	₱300 & above	Total
		grams		
Cagayan	273	273	174	260
Cebu	310	248	211	260
Mindanao	285	211	211	223
ALL AREAS	298	248	211	248

Within the same size of household, corn consumption per adult equivalent decreased with an increase in income. Low income households with large members had to resort to buying cheap food to meet the daily food requirements.

Occupation

The occupation of the wage earners affected the amounts of rice consumed. Contrary to the findings among rice-eating households, homes where the husband or major wage earners were pensionados, gamblers, and money lenders reported the highest daily corn consumption per adult equivalent (310 grams). Households where the husband or major wage earners were farmers or whose work required mascular exertion had the next highest per adult equivalent per day.

In households where the husbands or wage earners did not do manual labor, the average daily corn consumption per adult equivalent was 186 grams (table 20). This group consumed the least.

Corn Substitutes

Of the 343 corn-eating households, slightly more than two-thirds ran short of their corn supply. Seventy-one per cent of these used substitutes while 29 per cent either borrowed or bought corn on credit. The substitues used were bananas, camote, cassava, and bread. Cagayan households preferred rice "binlid" and cassava as subsitutes, whereas Cebu and Mindanao households preferred bananas and camote.

There were households which reported that during periods of low corn supply, they mixed corn with other foods. This, they said, was cheaper and more palatable.

HOMEMAKERS' PREFERENCES

TABLE 20.—*Daily corn consumption per adult equivalent by type of occupation of wage-earner, 343 households*

TYPE OF OCCUPATION OF WAGE-EARNER	CORN CONSUMPTION PER ADULT EQUIVALENT
Pensionado, gambler, money lender	310
Farmers, farm laborer, fishermen and related workers	285
Salesmen and related workers	260
Manuel workers and laborers	248
Craftsmen, factory operatives and related occupations	223
Workers in operating transport occupation	236
Proprietors, managers, administrators and officials	223
Service and related occupation	211
Clerical office and related workers	198
Professionals, technical and related workers	186
T O T A L	248

Because of its palatability, homemakers preferred the milled corn to the yellow variety. They considered yellow corn best fit as feed for poultry and swine.

Regarding display preferences, 59 per cent of the homemakers preferred to buy corn from closed bins as,according to them, it is free from dust, dirt, insects, and other foreign matter. Slightly more than one-third chose the open bin, and the rest were indifferent.

Prepacking was not widely accepted. About four-fifths of the households didn't favor buying prepackaged corn. As with the rice-buyers, they were afraid that the sellers might cheat them.

More than one-half of the households surveyed found impurities in their corn purchases. The more common of these were grit, weevils, hull, and manure.

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NITROGENOUS CONSTITUENTS OF VOLVARIA VOLVACEA[1/]

C. A. ORILLO AND A. R. CARANGAL, JR.

WITH TWO TEXT FIGURES

Analysis of the nitrogenous constituents of Volvaria volvacea were made. The pileus or cap contains more Kjeldahl nitrogen than the stem and the buttons. The level of amide nitrogen was higher than ammonium and nitrate nitrogen in these parts of the mushroom, with asparagine about five times that of glutamine. Urea could not be detected qualitatively with oxalic acid. About 16 naturally occurring amino acids were separated by paper chromatographic analysis of the alcoholic extract. Aspartic, serine, and glutamic acid were the most predominant amino acids. The acid hydrolyzate had less number of amino acids than the alcoholic extract but had the same predominance of amino acids.

The edible mushroom, *Volvaria volvacea,* has been grown successfully in the open in rice-straw beds and an approximate analysis of its chemical constituents has been made (Alicbusan and Ela, 1960). In view of the increasing interest in the culture of this mushroom, information on the nutritive value has often been sought by producers and consumers alike. Consequently, a study was conducted to determine the nitrogenous constituents of this species of mushroom. Mushroom could be a cheap source of protein.

Winton and Winton (1935) have made a compilation of the chemical composition of various species of mushrooms, but no report on the nitrogenous constituents of *V. volvacea* appears in the literature.

Reusser, Spencer and Sallams (1958) studied the protein and fat content of some mushrooms grown in submerged culture. They found that the efficiency of protein production was variable for the different culture media such as those containing glucose, molasses and sulfite waste liquor.

Various workers have analyzed the amino acid composition of mushroom. Seelkopf and Shuster (1957) determined the amount of 18 amino acids in 10 species of mushrooms. They found that the losses in animo acids increased during drying and storage. They

1/ Central Experiment Station Contribution No. 2077.

also compared the amino acids of mushrooms with those of other common foods. They concluded that the biological value of the mushroom proteins falls between that of vegetable and animal protein and that mushroom are poor in isoleucine and methionine. Paris, Durand and Bonnet (1957) made a study of 47 species of mushrooms by paper chromatographic analysis. They reported the presence of flavonoid pigments, fluorescent spots, sugars (mannitol, glucose, and tehalose), amines, urea, and other nitrogenous bases. In the case of amino acids, alanine, leucine, tyrosine, lysine, and valine were generally found but isoleucine, cysteic acid, and proline were rare. The distribution of amino acid liberated from *Agaricus hortensis* was shown by paper chromatography (Casimer, *et al.*, 1956, 1957). They also isolated a new substance with a proposed formula of $C_{12}H_{14}O_5N_2$.

MATERIALS AND METHODS

Samples of *Volvaria volvacea* were supplied by the Department of Plant Pathology. The samples for nitrogen determination were air dried for several hours and finally dried in the oven. Alcoholic extracts for free amino acids and amide determinations were prepared from fresh mushrooms.

The residue of the alcoholic extraction was dried in an oven, ground in a Wiley mill, and hydrolyzed for 24 hours with 6N H_2SO_4. The acid extract was treated with a little excess of CaO and filtered. The filtrate was concentrated to a small volume and de-ionized by being passed through the Dowex-50 (hydrogen form) column (Plaisted, 1958. The amino acid was eluted out with 4N NH_4OH and the eluate was concentrated for the amino acid analysis.

The nitrogen content of the dried mushrooms and of the residue after alcoholic extraction was determined by the semi-micro kjeldahl method (A.O.A.C., 1955). Ammonium, amide and nitrate nitrogen were determined from the alcoholic extract following the method of Varner *et al.* (1952). Relative amounts of asparagine and glutamine amide nitrogen were also analyzed (Carangal and Varner, 1959) from the alcoholic extract after treatment with Permutit which remove ammonium ions.

The amino acids of the alcoholic extract and acid hydrolyzate of the alcohol-insoluble residue were analyzed qualitatively by two-dimensional chromatography. The concentrated amino acid extracts were spotted on Whatman No. 1 filter paper (10 x 10 inches)

and developed with the solvent pair of 80 per cent phenol and n-butyl alcohol-acetic acid-water (4:1:1 by volume). The positions of the amino acids were revealed in the dried chromatogram by spraying with 0.3 per cent ninhydrin in ethyl alcohol and with isatin in acetone (Aronoff, 1958). Identity of the different positive-ninhydrin spots was established by characteristic color reactions with isatin and by comparison with Aronoff's chromatomap of amino acids.

RESULTS AND DISCUSSION

The nitrogen contents of the different parts of the mushroom, the buttons and the alcoholic extract are presented in table 1.

TABLE 1. — *Nitrogen content of Volvaria volvacea*

	NITROGEN CONTENT, PER CENT (DRY WEIGHT)				
	I	II	III	IV	Average
Pileus or cap	5.51	5.57	5.48	5.44	5.50
Stipe or stem	3.07	2.72	2.92	2.78	2.87
Button *a/*	2.57	2.43	2.64	2.52	2.54

Alcoholic extract ..... 38.5 mg. N/gm. total solids

a/ Young unopened mushrooms.

On the average, the pileus or cap had almost twice as much nitrogen as the stem, and the buttons or young unopened mushrooms had lower nitrogen content than either part of the open mushrooms. The alcoholic extract contained about 38.5 mg. of N per gram of total solids.

There were marked differences between the stalk and the cap in the level of soluble nitrogenous substances of the alcoholic extracts. The cap had more ammonium, amide, and nitrate nitrogen than the stalk (table 2a). These nitrogenous substances account for about 28 per cent of the nitrogen content of the alcoholic extract. In both parts, the amount of amide nitrogen was higher than ammonium and nitrate nitrogen.

TABLE 2a. — *Soluble nitrogenous substances in the alcoholic extract*

NITROGENOUS SUBSTANCES	STIPE			PILEUS		
	I	II	III	I	II	III
	meq. x 10^2 per 10 grams fresh weight					
Ammonium nitrogen	0.43	0.52	0.62	2.79	2.83	3.02
Amide nitrogen	1.13	1.23	1.01	5.29	4.73	4.92
Nitrate nitrogen	0.52	0.42	0.36	0.90	0.89	1.09

The level of asparagine was almost five times that of glutamine (table 2b). Qualitative tests with saturated oxalic acid of

TABLE 2b. — *Relative amounts of glutamine and asparagine* [a/] *in Volvaria volvacia*

TRIALS	ASPARAGINE	GLUTAMINE
	meq. x 10 ^{2}	
I	6.76	1.18
II	6.41	1.34
III	5.36	5.36
IV	7.34	1.72

Average ratio: Asparagine/glutamine equals 4.92

[a/] Whole mushroom was analyzed.

the alcoholic extract and water extract of the dried residue for urea gave negative results.

Almost all the naturally occurring amino acids were present in the alcoholic extract. About 16 amino acids were separated on the filter paper (fig. 1). On the basis of the relative intensity of the ninhydrin positive spots, the most predominant amino acids were aspartic, serine, glutamic, histidine, arginine, valine, leucine, and phenylalanine. Other amino acids present were alanine, threonine, tyrosine, glycine, lysine, cystine, and the amides, glutamine and asparagine. Methionine and isoleucine are probably present in negligible amounts which could hardly be detected with the isatin spray. Observations of the chromatogram under ultraviolet light (Mineralight, Model SL 3660) showed four unidentified spots occupying positions negative to ninhydrin. These spots are probably nitrogen bases such as purine and pyrimidine derivatives.

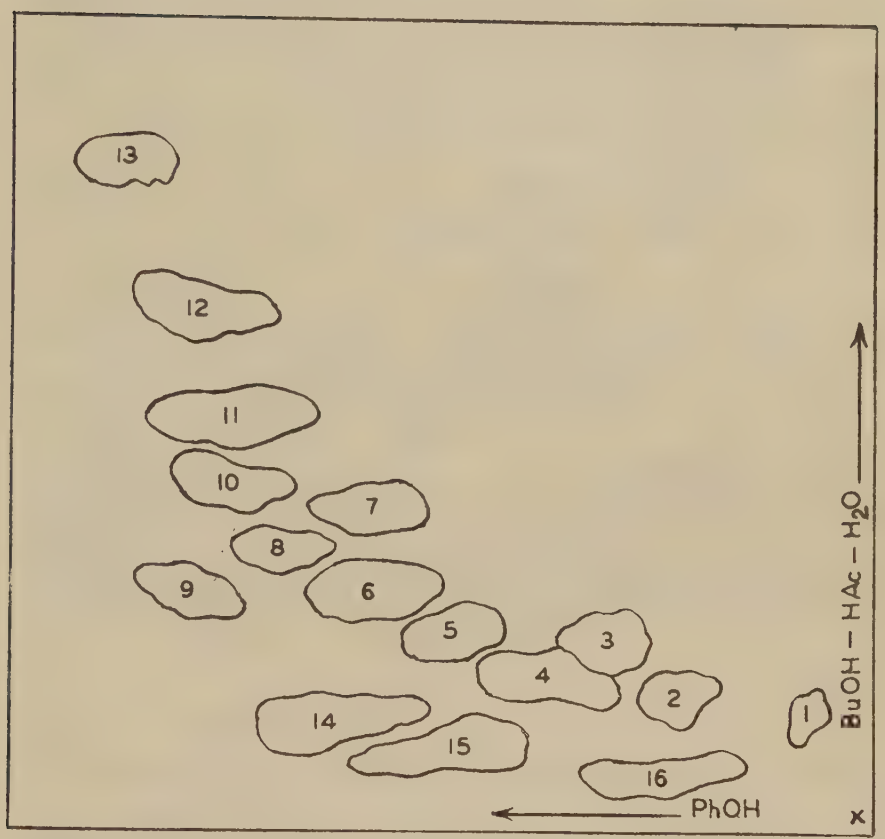

Fig. 1. — *Two-dimensional chromatogram of the amino acids of the alcoholic extract of* Volvaria volvacea. *The amino acids were* (1) *cystine,* (2) *aspartic,* (3) *serine,* (4) *glutamic,* (5) *glycine,* (6) *asparagine,* (7) *tyrosine,* (8) *threonine,* (9) *glutamine,* (10) *alanine,* (11) *valine-methionine,* (12) *isoleucine-phenylalanine,* (13) *leucine,* (14) *arginine,* (15) *histidine, and* (16) *lysine.* (*X — point of application.*)

The same amino acids found in the alcoholic extract were detected in the acid hydrolyzate (fig. 2). The order of occurrence of the amino acids was aspartic, serine, glutamic, threonine, leucine, phenylalanine, and glycine. Other acids such as cystine, lysine,

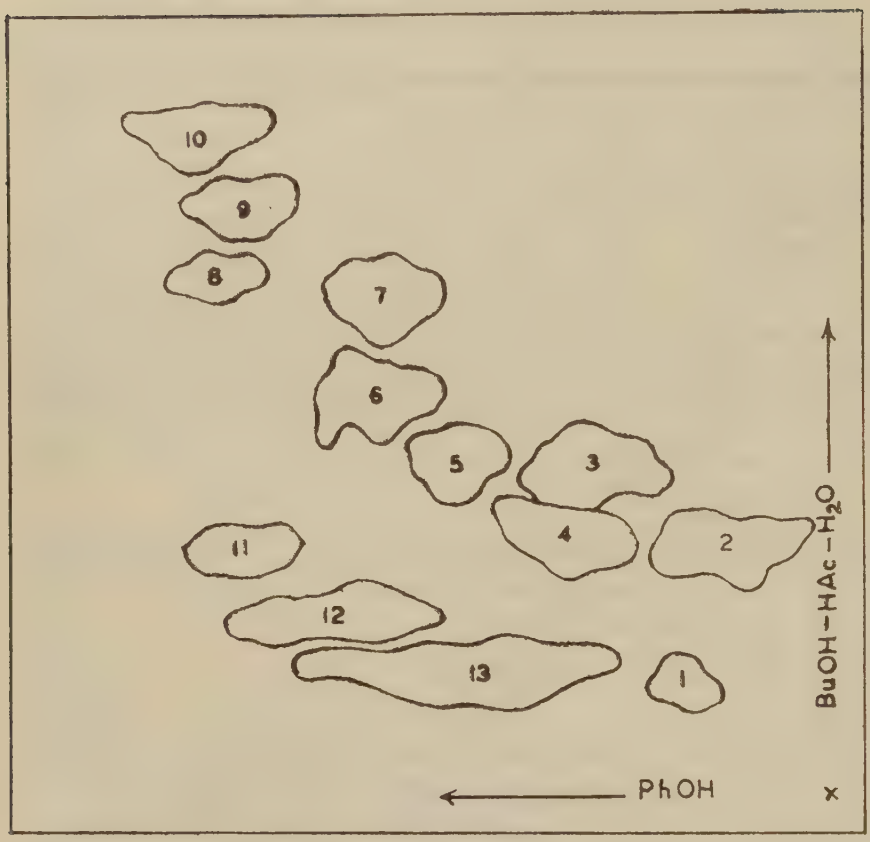

Fig. 2. — *Two-dimensional chromatogram of the amino acids of the acid hydrolyzate of* Volvaria volcacea. *The amino acids were* (1) *cystine,* (2) *aspartic,* (3) *serine,* (4) *glutamic,* (5) *glycine,* (6) *threonine-alanine,* (7) *tyrosine,* (8) *valine,* (9) *isoleucine-phenylalanine,* (10) *leucine,* (11) *arginine,* (12) *histidine, and* (13) *arginine,* (*x—point of application.*

histidine, arginine, valine, and tyrosine were also found. Proline and hydroxy-proline were not found.. Tryptophan was destroyed and the amides were hydrolyzed to the corresponding amino acids during the acid hydrolysis.

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TWO CONCENTRATIONS OF DDT AND METHOXYCHLOR IN THE CONTROL OF INSECTS AFFECTING GARLIC IN STORAGE 1/

A. F. BANAAG, P. P. BANDONG, AND R. A. LUIS—2/

WITH ONE TEXT FIGURE

DDT with dosages of 19 ml. and 9.5 ml. per gallon (3.78 liters) and Methoxychlor at 38 grams and 19 grams per galon (3.78 liters) were used. Of these two insecticides, DDT at 19 ml. gave the highest percentage of sound cloves, followed by DDT at 9.5 ml. Control gave the lowest percentage of sound cloves. Methoxychlor at 38 grams and 19 grams was inferior to DDT in controlling Ephestia elutella (Hubn), the insect that caused a great deal of damage to stored garlic.

In spite of the increase in garlic production in recent years, the price is exceedingly high during off-season months compared to that at harvest time. This price fluctuation is partly due to the rapid deterioration of garlic in storage as a result of insect infestation. Garlic bulbs and storage are attacked by several insects, rendering them unmarketable after a very short period. At present, no satisfactory method of controlling or preventing infestation of stored garlic by pests is practiced.

The present study was undertaken to determine the effectiveness of two concentrations—DDT and Methoxychlor, in the control of insect pest affecting stored garlic. It was conducted in the Department of Entomology, U. P. College of Agriculture, from May 8, 1959 to May 8, 1960.

MATERIALS AND METHODS

Twenty-five bundles of well matured, uninfested dry native garlic bulbs were divided into five groups of five bundles each.

1/ Central Experiment Station Contribution No. 2078.

2/ The authors are grateful to Dr. Silverio M. Cendana, Professor of Entomology and Zoology for his suggestions and for going over the manuscript.

There were 50 bulbs in each bundle. Except for the control, the bulbs in each bundle were dipped momentarily in prepared emulsions of the insecticides. The bulbs in the control bundles were dipped momentarily in tap water. After they were air dried, the bundles were arranged at random on open shelves in a heavily infested storage room. It was seen to it that the different bundles did not touch each other. The following insecticides and concentrations of DDT and Methoxychlor were used:

Insecticides	*Amount per gallon of water*
DDT, 25 per cent E.C.	19.0 ml.
	9.5 ml.
Mehoxychlor, 25 per cent W. P.	38.0 grams
	19.0 grams

Counts of damaged cloves in the different bundles were made one year after storage. The weights of the bulbs were taken on May 8, 1959; September 18, 1959; January 28, 1960; and May 8, 1960.

RESULTS AND DISCUSSION

Of the different stored product pests, among them *Litophilus oryzae* (Linn.), *Rhizopertha dominica* (F), *Corcyra cephalonica* (Staint), *Oryzaephilus surinamensis* (Linn.),*Tribolium castaneum* (Herbst), *Ephestia elutella* (Hubn.), *Laemophloeus pusillus* (Schouh)*Tenebroides mauritanicus* (L.), *Lasioderma serricorne* (F),*Sitotroga cereallela* (Oliv.), *and Plodia interpunctella* (Hubn.) only *Ephestia elutella* (Hubn.) damaged the bulbs in storage. The larvae of Ephestia entered individual cloves of the bulbs and feed on the contents, leaving the cloves empty, dry, and partially collapsed.

Effect of treatment on insect damage. Table 1 shows the percentage of sound cloves (undamaged by *Ephestia*) in the different treatments one year after storage. Analyzed statistically, the results show significantly more sound (undamaged) cloves in the treated than in the untreated bundles. Among the treated bundles, those treated with DDT had the biggest number of sound cloves (93.83 per cent at a dosage of 19 ml., and 89.68 per cent at 9.5 ml. per gallon) followed by Methoxychlor (87.25 per cent at concentration of 38 grams per gallon, and 75.18 per cent at 19 grams per gallon). The higher concentration of the insecticides gave significantly more protection than the lower concentrations at 1 per cent

TABLE 1. — *Percentage of sound cloves one year after treatment*

TREATMENT	REPLICATION I		II		III
	Actual	Angle	Actual	Angle	Actual
DDT, 25 per cent E.C.					
19.0 ml/gal.	94.82	76.82	92.77	74.44	97.17
9.5 ml/gal.	90.91	72.44	86.73	68.61	93.30
Methoxychlor 25 per cent W. P.					
38 gram/gal.	90.48	72.05	98.17	82.29	84.42
19 grams/gal.	68.92	56.11	89.50	9.09	69.36
Control (untreated) ...	49.26	44.60	44.22	41.67	29.21

TABLE 1 — Continued

IV		V		MEAN	
Angle	Actual	Angle	Actual	Angle	
80.37	92.05	73.68	92.34	73.89	93.83	75.58
75.00	90.24	71.76	87.20	69.04	89.68	71.28
66.74	93.47	75.23	69.73	56.60	87.25	69.12
56.42	69.91	56.73	78.23	62.17	75.18	60.13
32.71	37.56	37.82	30.36	33.46	38.12	38.12
H S D (T) at 5 per cent — 12.25						
1 per cent — 15.54						

probability level.

Effect on weight of garlic bulb. The initial weight and weights after four months, eight months, and one year of the bulbs in the different treatments are shown in table 2a and figure 1. The initial

TABLE 2a. — *Mean weight in grams of 50 bulbs at different rates of observation*[a]/

TREATMENT	MAY 8, 1959	SEPT. 18, 1959	JAN. 28, 1960	MAY 8,1960
DDT, 25% E.C.				
19.0 ml.	362.10	321.12	270.44	257.79
9.5 ml.	363.42	318.66	268.16	236.76
Methoxychlor 25% W.P.				
38.0 grams	362.16	317.84	259.29	239.63
19.0 grams	356.20	293.80	227.44	203.16
Control	360.84	265.62	176.40	155.76
H S D (T) at 5%	b/	56.20	45.08	33.08
1%	b/	b/	57.15	41.94

a/ Each column represents the mean of five replicates.
b/ Insignificant.

weights of the bulbs showed no significant differences between treated and untreated bundles. After four months, the treated bulbs were significantly heavier than the control at five per cent level. The weights of all the treated bulbs were significantly heavier at

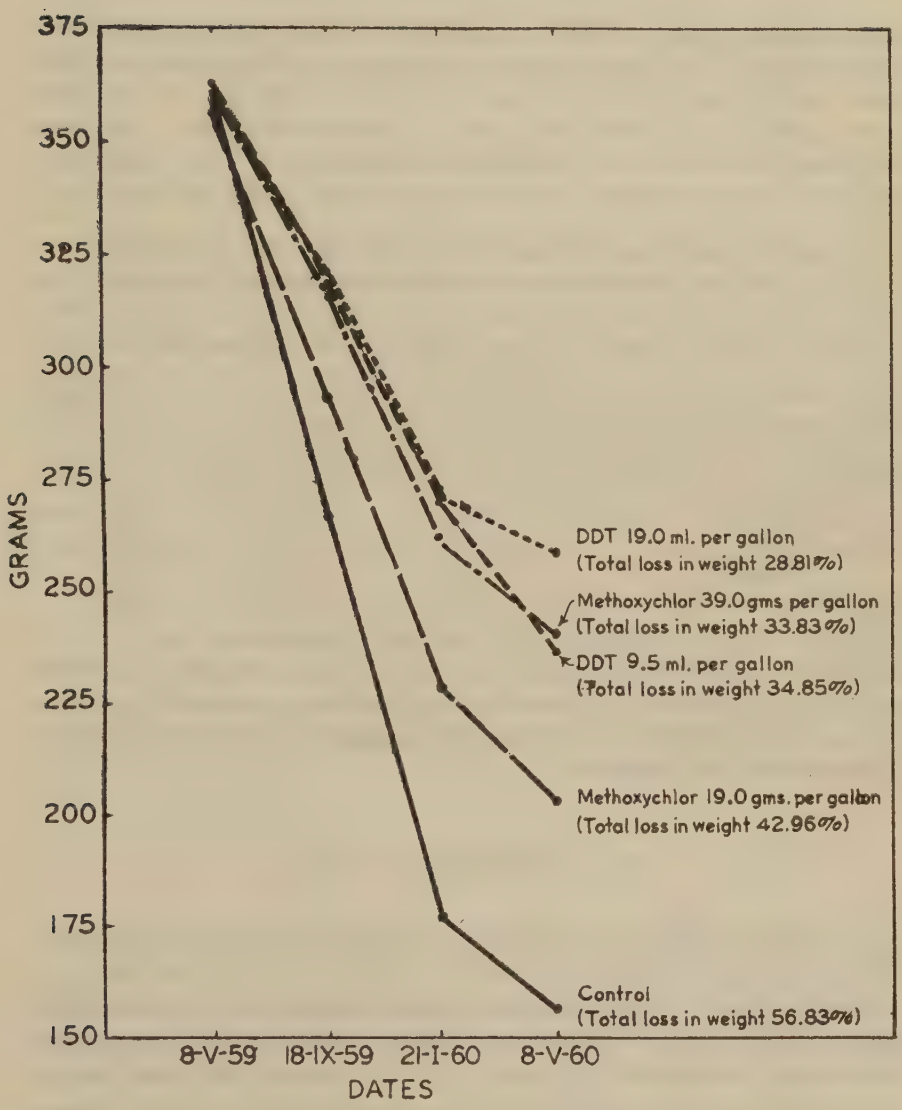

Fig. 1. — *Mean-weight decline of 50 bulbs in the different treatments at different dates of observation.*

both the five and one per cent levels than that of the control after eights months and after one year. Of the two insecticides tested, DDT at dosages of 19 ml. and 9.5 ml. per gallon gave the highest

mean weight of bulbs (257.79 grams and 236.76 grams, respectively), followed closely by Methoxychlor at dosages of 38 grams and 19.0 grams per gallon (239.63 grams and 203.16 grams, respectively) at the termination (after one year) of the experiment. The least was given by the control, which was 155.76 grams. No significant differences were obtained between insecticides and concentrations.

The effects of the different treatments are also reflected in the mean per cent loss in weight of the bulbs (table 2a). DDT at 19 ml.

TABLE 2b. — *Mean percent loss in weight of garlic bulbs at different dates of observation*

TREATMENT	MAY 8,1959	SEPT. 18, 1959	JAN. 28, 1960	MAY 8, 1960
DDT, 25% E.C.				
19.0 ml.	0	11.32	25.31	28.81
9.5 ml	0	12.32	26.21	34.85
Methoxychlor, 25% W.P.				
38.0 grams	0	12.24	28.40	33.83
19.0	0	17.52	36.15	42.96
Control	0	26.39	51.11	56.83

and 9.5 ml. had the least mean per cent loss in weight with 28.81 and 34.85, respectively. Methoxychlor at two concentrations was the next, giving 33.83 and 42.96. The untreated bulbs had the highest loss in weight of 56.83.

SUMMARY

1. Of the different stored product pests, only *Ephestia elutella* (Hubn.) was observed to damage the garlic bulbs in storage.

2. The results obtained on the insect damage in two concentrations of DDT and Methoxychlor showed significantly more sound (undamaged) cloves in the treated than the untreated bundles.

3. DDT—treated bundles had the most number of sound cloves (93.83 per cent at dosage of 19.ml. and 89.68 per cent at 9.5 ml. to a gallon of water).

4. The effects on the weight of garlic bulbs showed that DDT at 19 ml. and 9.5 ml. had the highest mean weight of 302.86 and 296.75 grams, respectively.

5. The least mean per cent loss in weight was also given by DDT at 19 ml. and 9.5 ml. to a gallon of water.

NICKEL AS THE POSSIBLE CAUSE OF COCONUT "BOANG" IN THE TIBLAWAN PLANTATION, DAVAO [1/]

R. K. DE LA FUENTE

Nickel was first observed to be high in amounts in the soils of the Tiblawan Plantation when a sample of the soil, together with some 20-odd others from Laguna, Quezon and the Bicol provinces was analyzed for copper. The routine analysis for copper with the reagent diethyldithiocarbamate (Snell and Snell, 1949) [2/] necessitates the removal of nickel with dimethylglyoxime, since this element, like copper, gives the same color reaction with the reagent. Upon the addition of dimethylglyoxime, it was found that the soil of the Tiblawan Plantation was the only sample that gave a wine red precipitate, indicating the presence of nickel.

Analysis for this element was therefore pursued further in both soil and plant materials in the hope that some light might be thrown on the "boang" disease of coconut. The disease is most severe in some section of Davao province, particularly the southern part of the peninsula where the Tiblawan Plantation is located. It is characterized by the production of empty or improperly "fleshed" nuts.

MATERIALS AND METHODS

The oil and plant samples were gathered in the summer of 1960 by Drs. J. R. Velasco and J. Davide. [3/] The method used in the analysis for nickel is essentially that of Sandell (1950). [4/] It consists of extracting the nickel dimethylglyoximate with chloroform and then washing it with dilute ammonium hydroxide. The element is brought back to the aqueous phase by shaking it with dilute hydrochloric acid. It is then oxidized with bromine water. The pH of the solu-

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1/ Central Experiment Station Contribution No. 2079.

2/ F. D. Snell and C. T. Snell, Colorimetric methods of analysis. Vol. 2. D. Van Nostrand Co. Inc., New York, 1949.

3/ J. R. Velasco, "Boang" of coconut in Davao, U.P. College of Agriculture Monthly Bulletin, 25, 1 (1960).

4/ E. B. Sandell, Colorimetric determination of traces of metals. 2nd ed. Interscience Publishers, New York, 1953.

tion is raised with concentrated ammonium hydroxide and dimethlyglyoxime is added to develop the reddish brown color. This is then read in a photoelectric colorimeter.

RESULTS AND DISCUSSION

Table 1 shows the concentration of total and exchangeable nickel in some soils. The high amount of nickel in the soils of the

TABLE 1.—*The total and exchangeable nickel of some soils*

SAMPLE	TOTAL	EXCHANGEABLE
	ppm	*ppm*
1. Almendras Plantation, Davao	Trace a/	Trace b/
2a. Tiblawan Plantation, Davao	1,588.6	5.8
2b. " " "	1,163.9	6.4
2c. " " "	1,524.3	4.8
3. Sirawan, Torell, Davao	Trace	—
4. College, Laguna	"	—
5. San Miguel Island, Albay	"	—
6. Labo, Camarines Norte	"	—

a/ Not detected in about 100 milligrams of fused soil in 50 ml. solution.
b/ Not detected in five grams soil sample in 50 ml. solution.

Tiblawan Plantation is obvious. The total amount in the three samples ranged from a little over 1,100 to about 1,600 ppm. The exchangeable portion extracted with IN ammonium acetate ranged from 4.8 to 6.4 ppm.

Extensive analysis of nickel in Hawaiian soils (Chang and Sherman, 1953) 5/ showed that the total content ranged from 98 to 661 ppm, and the exchangeable form (IN ammonium acetate), from 0.31 to 2.56 ppm. This, they considered to be much higher than the normal soils reported from other parts of the world. Clearly, these figures are less than one-half that of the soils from the Tiblawan Plantation.

Soils 2a and 2c were more or less the same in that not much "boang" was observed and the surface soil was quite deep. While soil 2a was planted to nine-year-old trees, soil 2c had 30-year-old

5/ A. T. Chang and G. D. Sherman, Hawaii Agric. Expt. Sta. Tech. Bull., 19, 1-25 (1953).

ones. Soil 2b was also planted to 30-year-old cocounts, and this was the section where most of the trees were abnormal. Although soil 2b had a smaller amount of total nickel, its exchangeable form was much greater compared with the two other soils.

Nickel in the coconut plant samples from other plantations shown in table 1 could not be detected, while the nickel content of the fronds, endosperm, and shell from the Tiblawan Plantation were 15.5, 10.6, and 1.3 ppm, respectively.

When the nuts were opened, three of them had the peculiar smell of rancid oil, and one was quite normal. The normal endosperm was found to contain two-thirds the amount of nickel of the abnormal ones and the concentration in the shell could hardly be detected.

As to the physiological significance of nickel to plants, literature reports both beneficial and harmful effects although the latter outweights the former. Tomato seedlings did not last long in culture solutions containing 1 ppm nickel (Chang and Sherman, 1953). 6/

It is premature to decide, on the basis of this meager evidence, whether or not nickel is involved in the "boang" disease of coconuts. Experiments are being conducted to shed light on this matter. Should it be demonstrated to be involved, it is hoped that the question of whether nickel exerts a direct toxic effect on the plant or it has an indirect effect in that it interferes with the metabolism of some essential element, will be answered. It is hoped, too, that means will be devised to minimize if not inactivate high levels of available nickel in soils.

6/ Ibid.

UNIFORMITY IN MATURITY OF TWO RICE VARIETIES GROWN AS TRANSPLANTED RATOON [1/]

D. A. RAMIREZ AND R. C. DUMLAO [2/]

Transplanted basal tillers of Peta and Tjere mas were as uniform in maturity as the seedling crop. The basal tillers matured 14 to 20 days earlier than the seedling crops.

The transplanted runners were less uniform in maturity but were also earlier-maturing than the "dapog"-raised seedling crop by 12 to 17 days.

With Tjere mas, both the transplanted basal tillers and runners gave higher yields than the seedling crops. With Peta, comparison of relative yields was duplicated by the differential effects of lodging at different stages of maturity.

The asexually propagated plants were generally shorter than the seedling plants.

Several lowland rice varieties have been observed to produce vigorous ratoons even when no more care is given after the main crop has been harvested. Previous studies on ratooning indicate that the rather low yield of the ratoon crop is mainly due to the uneven maturity of the crop. Because of this uneven maturity, a ratoon crop has to be harvested two to four times at one to three weeks interval, [3/]and even this number and frequency of harvestings do not prevent losses due to shattering of unharvested mature grains and the harvesting of immature kernels.

De Jesus *et al.* [4/] found that transplanted ratoon had a more uniform heading and maturity period than the ratoon crop. This, however, was not yet satisfactory since the heading period lasted for more than a week.

It has been observed that the recommended lowland rice varieties, Peta and Tjere mas, like FB-24 [5/], also produce runners which

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1/ Central Experiment Station Contribution No. 2080.

2/ The writers are grateful to Mr. I. S. Santos of the Division of Plant Breeding for his suggestions on the manuscript.

3/ L. P. Altamarino, "The influence of spacing on the development, yield and agronomic characters of rice ratoon crop." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, April, 1959. Unpublished).

4/ J. C. de Jesus, "Comparative performance of transplanted seedlings, drilled seeds, transplanted ratoons tillers and ratoon crops of Milbuen 5 (3)." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, April 1959. Unpublished).

5/ J. N. Tepora and D. L. Umali, The Philippine Agriculturist, 41, 191-193 (1957).

could likewise be used as planting materials.

MATERIALS AND METHODS

Two recommended lowland varieties observed to produce runners, Peta and Tjere mas, were used in this study. These varieties are also non-seasonal. The planting materials used were: (1) ratoon tillers that arise from the basal nodes of the primary stalk, referred to as basal tillers; (2) runners; and (3) "dapog"-raised seedlings to serve as control.

Two plantings were done: one in May, 1959 and the other in November, 1959. The first planting had two replications while the second had three. Transplanting of the "dapog" seedlings was done 12 days after sowing, and of the basal tillers and the runners, 12 day after harvesting the main crop.

Data on maturity period, duration of heading, yield, and plant height were collected.

RESULTS AND DISCUSSSION

Uniform heading was observed on the crops grown from transplanted basal tillers in the two seasons of planting of both varieties, Peta and Tjere mas. The heading period lasted for two to three days only, which was the same as that of the crop grown from "dapog"-raised sedlings.

On the other hand, the heading period of the runner crop lasted for five to seven days. This longer heading period could be attributed to the differences in the physiological age of the planting materials. The general observation was that runners collected from an upper node mature earlier than those from a node nearer the base of the primary stalk.

Both the runners and basal tillers headed earlier than the "dapog" crop in the two seasons of planting (tables 1 and 2). In the first planting of Peta, the basal tiller and the runner crops were earlier by 20 and 17 days, respectively, than the "dapog" crop. For Tjere mas, the crop grown from the basal tillers and runner crops headed 14 and 12 days earlier, respectively, than the "dapog" crop. A similar trend was observed in the second planting.

Yield data were collected only from the first planting because the second crop was badly damaged by birds and rats. With Tjere mas, the crops grown from the basal tillers and the runners gave yields higher than that from the "dapog" crop (table 1). The basal

TABLE 1.—*Number of days from transplanting to maturity, mean yield, and plant height of Tjere mas and Peta grown from "dapog"-raised seedlings and transplanted runners and basal tillers in the first planting*

TREATMENT	MATURITY		MEAN YIELD		PLANT HEIGHT	
	Peta	Tjere mas	Peta	Tjere mas	Peta	Tjere mas
	days		*cav./ha.*		*cm.*	
"Dapog" (control)	141	139	42.0	79.7	163.7	146.5
Runner	124	127	96.6	96.4	154.3	149.5
Basal tillers	121	125	101.0	106.1	154.7	149.5

TABLE 2.—*Number of days from transplanting to maturity and plant height of Tjere mas and Peta grown from "dapog" raised seedlings and transplanted runners and basal tillers in the second planting.*

TREATMENT	MATURITY		PLANT HEIGHT	
	Peta	Tjere mas	Peta	Tjere mas
"Dapog" (control)	136	134	132.5	124.0
Runner	123	122	120.5	109.1
Basal Tiller	120	118	122.3	108.3

tillers had a mean yield of 106.1 cavans per hectare; the runners, 96.4 cavans; and the "dapog" crop, 77.7 cavans. Peta gave a much lower yield in the "dapog" culture, most probably on account of lodging during the heading period caused by typhoon "Emma". In an earlier experiment, Umali *et al.* (1956) 6/ noted that the yields of Mangasa, Thailand and Milfor 6 (2) were reduced by 40-76 per cent when the crop lodged during the heading stage. It will not be well therefore to compare critically the yields of Peta when asexually propagated and when seed ("dapog"-raised) propagated.

The mean yields of the asexually propagated crops, however, may be compared with that of Peta in the yield test conducted by the Plant Breeding Division during the same season since these yield tests were also grown from "dapog-raised seedlings. The mean yields of the basal tiller and the runner crops, which were injured by typhoon Emma and lodged when the grains were already formed, were 101.0 and 96.6 cavans per hectare, respectively. The yield of

6/ D. L. Umali, E. S. Castillo, and P. S. Castillo, The Philippine Agriculturist. 40, 178-184 (1956).

"dapog"-raised Peta in the test conducted near the area in which the crops used in this study were grown was 95.7 cavans per hectare. For Peta, therefore, it cannot be stated whether or not the asexually propagated crops were superior in yield to the sexually propagated ones.

Plants from both the runner and basal tiller crops of Peta were shorter than those from the "dapog" crops in the two plantings. The "dapog" plants were taller by about 10 centimeters than the asexually propagated plants. A similar trend was observed in the second planting of Tjere mas (table 2). In the first planting, however, the reverse was true: "dapog" plants were shorter by three centimeters than those grown from runners and basal tillers.

In the two plantings, the asexually propagated plants of both varieties were more susceptible to root rot than the seedling plants.

THE AVAILABILITY OF PHOSPHORUS TO RICE GROWN UNDER FLOODED CONDITIONS AS EVALUATED BY ISOTOPE DILUTION TECHNIQUE 1/

JORGE G. DAVIDE—2/

WITH TWO TEXT FIGURES

In a medium consisting of sand-cation exchange resin-nutrient solution, which would not interact directly with the phosphorus sources and which did not contain native phosphate, tillering, dry matter and phosphorus yields of rice were increased by flooding. The availability of calcium, aluminum, and iron phosphates as measured by isotope dilution technique, using the A-value as a criterion, were markedly increased by flooding.

Significant changes in many of the soil fertility factors occur either as a result of the alternate wetting and drying or of the continuous submergence of soils (Kelly, 1914; Janssen and Metzger, 1928; Bartholomew, 1928; Clark and Resnicky, 1956). Bartholomew (1931), Knapp (1933), and Beacher (1952) reported that flooded rice showed inconsistent or no response to phosphorus fertilization, even on soils where upland crops responded considerably to phosphate. The same phenomenon has been observed by Galvez *et al.* (1956) and Nelson (1957), and it appears generally true that flooding somehow affects plant response to phosphate fertilization. Shapiro (1958) reported that both the yield and phosphorus uptake increased under flooded conditions. This was attributed to an inincrease in the availability of either the soil or the fertilizer phosphorus applied. The increased availability of phosphorus when the soils were flooded has been ascribed to: (1) the increased solubility of iron phosphate; and (2) the hydrolysis of soil phosphates brought about by the reducing conditions of the soil (Fujiwara, 1950; Mitsui, 1954).

1/ General Contribution No. 911. The research reported here was done as part of a thesis submitted by the author in partial fulfillment of the Ph. D. requirements in North Carolina State College.

2/ The author is grateful to Dr. N. T. Coleman for his guidance and encouragement in making this study.

Since iron phosphate may exist in soils or may form as an end-product of phosphate fixation (Chang and Jackson, 1957a) and since iron is reduced in submerged soils (ponnamperuma)[3/] then it has been supposed that this is the reason why phosphate availability seems greater, or at least rice grows better, in the flooded condition. Although the reasons for phosphate response differences which have been observed for upland and flooded soils are not yet clear, considerable effort has been expended in trying to explain them in terms of the forms and solubility of phosphate under these two sets of conditions. Phosphorus is known to react with many soils and the phosphorus supply pattern of soils vary (Fried and Shapiro, 1956).

In this experiment, the aim was to measure, by isotope dilution, the availabilities of various forms of inorganic phosphates to rice plants grown under flooded and non-flooded conditions in a medium that would not interact with the native or added phosphate.

MATERIALS AND METHOD

Sand-exchange resin mixture was used as the growth medium instead of soil. This choice was made in order that the effect of flooding on phosphate availability could be evaluated and defined without interactions due to soil differences. A carboxylic cation exchange resin, IRC-50 (Rohn and Haas Co.) having an exchange capacity of 4 m.e. per gm., was used to supply cation nutrients and to buffer the substrate. One-half of the cation exchange capacity was saturated with calcium and magnesium in the amounts of 1.5 and 0.5 m.e. per gm., respectively. This was done by shaking together a known weight of resin, water, and the desired quantities of calcium and magnesium hydroxides. The suspension was equilibrated by shaking for 48 hours at which time no visible evidence of $Ca(OH)_2$ and $Mg(OH)_2$ remained, filtered, and air-dried.

The charge for each pot was prepared by mixing 25 gm. of the dried resin with 1000 gm. of washed sand. The phosphate treatments were 50,000, and 200 pp2m. P_2O_5 as reagent grade monocalcium phosphate and 250 pp2m. as precipitated iron and aluminum phosphates. The latter two materials were prepared

3/ F. N. Ponnamperuma. "The chemistry of submerged soils in relation to the growth and yield of rice." Ph. D. Thesis, Cornell University (1955).

by digestion of $ALCl_3$ or $FeCl_3$ with $N_aH_2PO_4$ (Chang and Jackson, 1957b). The phosphate materials were mixed uniformly with appropriate portions of the sand-resin mixtures before they were put into one-quart polyethylene boxes. When the culture was to be non-flooded, a 3/4 cm.-diameter hole was provided at the bottom of each container.

All pots received a uniform initial application of nitrogen and potassium. Nitrogen as $(NH_4)_2SO_4$ and potassium as KCl were added at the rates of 50 and 100 ppm., respectively. An additional 50 ppm. of nitrogen was added when the plants were about four weeks old. Supplementary additions of both N and K were made during the growth period as needs were evidenced by visual symptoms. The following sources and rates of minor elements were added to each pot:

B— 0.5 ppm. as H_3BO_3
Mn— 0.5 ppm. as $MnSO_4$
Zn— 0.05 ppm. as $ZnCl_2$
Cu— 0.02 ppm. as $CuSO_45H_2O$
Mo— 0.01 ppm. as MoO_3
Fe — 1 ppm. every other day as Fe-chelate.

To insure inoculation with organisms capable of reduction, and an energy source for them, water extracts from a surface soil and sucrose at the rate of 0.1 per cent by weight were added to all pots. With the non-flooded sets, the nutrient solutions were recycled daily.

Ten to 12 rice seeds were sown in each pot, and the stand was later thinned to four plants. When the plants were 35 days old, one-half gram of "resin-P^{32}" was applied through holes punched at four equally spaced points to a depth of about 1 to 1 1/2 inches. Before the resin was applied, the flooded pots were allowed to dry slightly to avoid water seeping through the holes. The holes were filled with sand after the "resin-P^{32}" placement and the water-level was then restored, in the case of the flooded pots. The "resin-P^{32}" was prepared by saturating an anion-exchange resin, IRA-400 (OH), with phosphoric acid spiked with P^{32}. The resulting preparation had a specific activity of 6387 cpm/mgm. P at a certain reference time. The amount of phosphorus added through the "resin-P^{32} was equivalent to 25 ppm. P to each pot.

The plants were harvested 60 days after seeding. The plant materials were chopped and dried at 70°C. Phosphorus in the plant materials was determined by dry-ashing at 500°C. overnight. The ash was dissolved in 1 *N* HNO_3 and centrifuged. Aliquots of

the clear extract were used for phosphorus determination, using, the molybdate-vanadate method (Kitson and Mellon, 1944).

Radioactive phosphorus was assayed with the solution-counting technique. In all countings, 5 ml. of solution contained in a plastic cup and positioned reproducibly with respect to a thin-window Geiger tube, was used. To correct for background and decay, standards prepared from the HNO_3 extract of the "resin-P^{32}" were counted along with the samples.

From the ratio of the specific activity in the plant to the specific activity in the "resin-P^{32}" and the amount of resin-phosphate added, A-values were calculated according to the equation developed by Fried and Dean (1952).

$$A = \frac{(B\ (100 - y)}{y},$$

where A and B are the available soil and standard fertilizer phosphorus, respectively, and y is the percentage of the phosphorus in the plant derived from the standard labeled fertilizer.

RESULTS AND DISCUSSION

Growth and yield characteristics. The mean values for the number of plants, dry matter yield of tops, and yield of phosphorus as influenced by phosphorus sources and flooding are shown in table 1. Better vegetative growth occurred in the flooded media. The plants tillered better and yielded more when flooded. This was true where phosphorus was added either as monocalcium, iron, or aluminum phosphate. In the nonflooded situation, tillering at the 250-pp2m. P_2O_5 rate as aluminum or iron phosphate was comparable to that observed with 50 or 100 pp2m. P_2O_5 as monocalcium phosphate. Plants tillered more with aluminum phosphate than with iron phosphate when the substrate was flooded.

The dry matter yields followed similar trends as the number of plants. In both the flooded and nonflooded series, the yields obtained from iron and aluminum phosphate treatments were the same; but yields were much higher on the flooded pots. Furthermore, flooding apparently resulted in an increased capacity of the plants to absorb phosphorus. This seems to have been a direct result of the overall increased growth as a consequence of submergence. The phosphorus uptake, as shown by the yield of phosphorus, was much greater under flooded conditions, especially where monocalcium phosphate was the source. Phosphorus uptake from 250 lbs. of P_2O_5 as aluminum or iron phosphate was as great as that

TABLE 1. — *Total number of plants, dry matter, and phosphorus yields in flooded and nonflooded sand-resin cultures*

P-SOURCE	RATE a/	NO. OF PLANTS b/		DRY MATTER		P-YIELD	
		Flooded	Non-Flooded	Flooded	Non-Flooded	Flooded	Non-Flooded
				gm.	*gm.*	*mg.*	*mg.*
$Ca(H_2PO_4)_2$	50	18.3	7.7	4.81	2.42	6.73	4.57
	100	21.7	10.0	5.66	2.73	8.97	5.93
	200	20.3	11.7	6.02	3.00	13.03	5.67
$AlPO_4$	250	18.7	10.0	4.89	2.54	6.83	3.97
$FePO_4$	250	14.0	10.0	4.01	2.10	6.07	4.93

	No. of plants	Dry matter	P-yield
L.S.D. (.05) between two P- treatment means at the same flooding	3.7	0.89	1.36
L.S.D. (.01) between two P-treatment means at the same flooding	5.0	1.22	1.85
L.S.D. (.05) between two flooding means at the same P-treatment	3.7	1.80	1.78
L.S.D. (.01) between two flooding means at the same P-treatment	5.8	3.62	3.09

a/ As lbs. P_2O_5/2,000,000 lbs. of the medium

b/ Includes tillers, substracting four in every case gives the number of tillers.

from 50 lbs. as monocalcium phosphate from either the flooded or nonflooded medium.

A-values. The availabilities of the different forms of phosphates, in terms of the A-values are shown in table 2.

Table 2 shows that excellent recovery of monocalcium phosphate was obtained. The A-values for the flooded substrate were slightly higher or nearly equal to the rates of application of monocalcium phosphate. This relationship indicates that monocalcium phosphate was equally or a little more available than the resin-phosphate used as the tracer P^{32} carrier. This would justify the use of resin-phosphate in the A-value technique in evaluating phosphorus availability.

It is, however, interesting to note that in the nonflooded pots there was smaller recovery of monocalcium phosphate as indicated by lower A-values, particularly at the 200-lbs. rate. Perhaps at this

TABLE 2.—*Phosphorus availability in flooded and non-flooded sand-resin media measured by the A-values*

P-SOURCE	RATE	A-VALUE Flooded	Nonflooded
	lbs. P_2O_5/A	*lbs. P_2O_5/A*	
$Ca(H_2PO_4)_2$	50	57	47
	100	101	82
	200	237	125
$AlPO_4$	250	58	34
$FePO_4$	250	88	48
L.S.D. (.05) between two P-sources at the same flooding treatments		=	47
L.S.D. (.01) between two P-sources at the same flooding treatments		=	64
L.S.D. (.05) between flooding treatments at the same P-source		=	46
L.S.D. (.01) between flooding treatments at the same P-source		=	66

rate there were not enough plants (table 1) to utilize all the available phosphate. This, however, is unlikely to be the reason. The data presented in table 3 might be instructive. The calculation of the A-values involved the radioactivity of the phosphorus in the plant, which, in turn, was affected by the phosphorus concentration. It is evident from table 3 that the activity, in counts per minute, was lower generally in the flooded treatments. In the case where 200 lbs. P_2O_5 as monocalcium phosphate was applied, 67.3 per cent and 49.8 per cent of phosphorus in the plant were calculated as being derived from the medium, in the flooded and nonflooded treatments, respectively.

It is quite possible that the larger amounts of P^{32} in the plants grown under the nonflooded conditions is the result of lack of isotopic equilibrium in the substrate, and not because of a lowered availability of the monocalcium phosphate.

The availabilities (as indicated by A-values) of iron and alu-

TABLE 3—*P32 activity and phosphorus contents of plants in flooded and nonflooded sand-resin cultures*

		FLOODED			NON-FLOODED		
		Activity	P in plant	P from medium	Activity	P in plant	P from medium
	lbs.P2O5/A	*cpm*	*per cent*	*per cent*	*cpm*	*per cent*	*per cent*
$Ca(H_2PO_4)_2$	50	3,006	0.14	32.9	4,646	0.20	28.2
	100	2,694	0.16	46.6	3,705	0.20	41.1
	200	2,343	0.22	67.3	3,535	0.22	49.8
$AlPO_4$	250	2,995	0.14	33.6	3,986	0.18	22.5
$FePO_4$	250	3,298	0.15	43.3	4,215	0.22	29.4
$Ca(H_2PO_4)_2$	50	2.38		1.99	1.47		1.20
	100	2.17		2.07	1.51		1.24
	200	1.74		2.01	2.30		1.90
$AlPO_4$	250	1.87		1.93	1.72		1.69
$FePO_4$	250	1.40		1.92	1.23		1.83

minum phosphate relative to that of calcium-phosphate are shown graphically in figure 1. Here the A-values for the flooded and nonflooded media are plotted against the rate of P_2O_5 addition as monocalcium phosphate. The values for the iron and aluminum phosphates are indicated by horizontal lines intersecting the appropriate calcium phosphate curves. The curve for the nonflooded medium was extrapolated to the zero rate, in order to show clearly the position of aluminum phosphate. The availabilities of iron and aluminum phosphates in terms of calcium phosphate are obtained by drawing vertical lines from the point of intersection down to the X-axis. The "calcium phosphate equivalent" for aluminum phosphate (250 lbs. P_2O_5 per acre) in the flooded medium was about 50 lbs. It was smaller in the nonflooded situation. Two hundred and fifty pounds of P_2O_5 as iron phosphate was equivalent to 33 and 56 lbs. as monocalcium phosphate in the flooded and nonflooded series, respectively.

The data shown in table 4 summarize the effects of flooding on plant growth and on the availability of calcium, aluminum, and iron phosphates. The numbers shown are the ratios of the results obtained for the flooded and nonflooded series, and are entitled "flooding indices." In all cases, the values obtained were greater

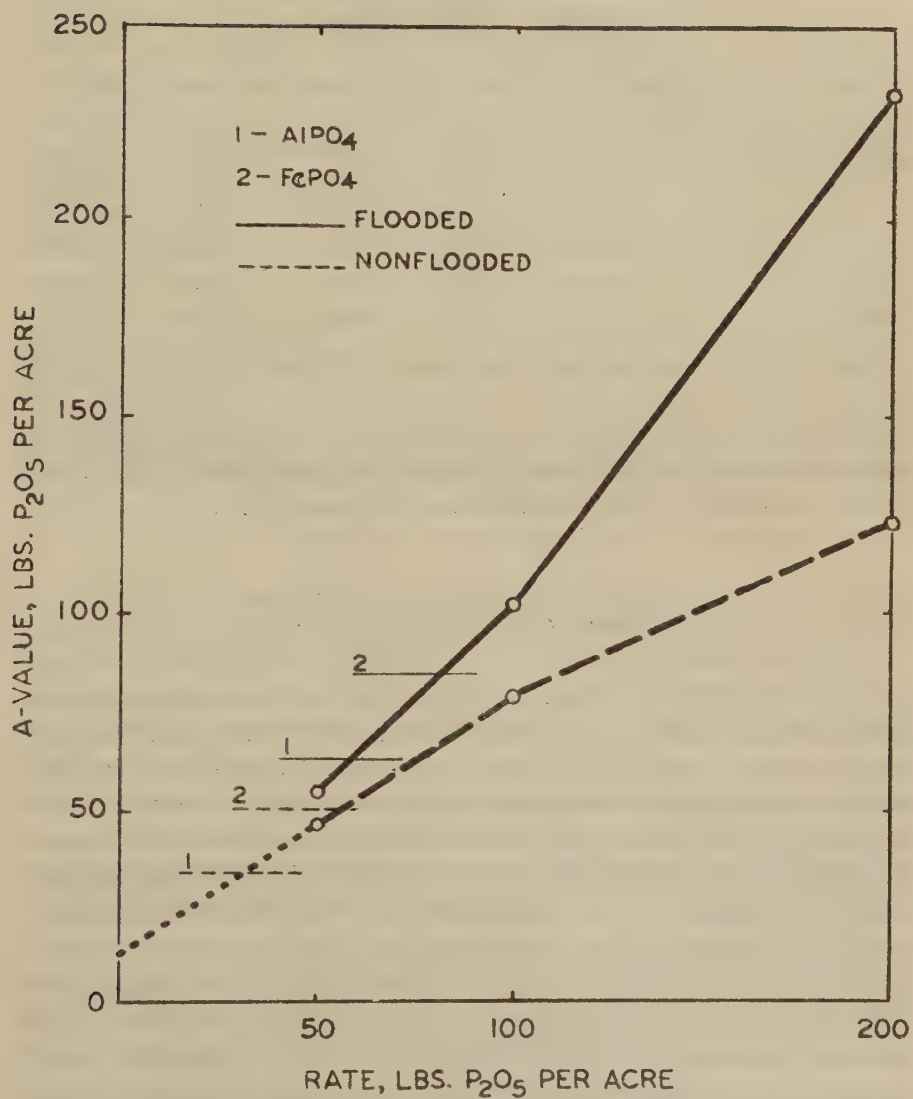

Fig. 1 — *A-values obtained from various rates of monocalcium phosphate in flooded and non-flooded sand-resin substrates.*

TABLE 4.—*Phosphate "flooding index", expressed as the ratio of flooded to non-flooded*

P-SOURCE	RATE	NO. OF PLANTS	DRY MATER YIELD	P-YIELD	A-VALUES
	lbs. P_2O_5/A				
$Ca(H_2PO_4)_2$	50	2.38	1.99	1.47	1.20
	100	2.17	2.07	1.51	1.24
	200	1.74	2.01	2.30	1.90
$AlPO_4$	250	1.87	1.93	1.72	1.69
$FePO_4$	250	1.40	1.92	1.23	1.83

than 1.0. This clearly illustrates that, in the non-interacting system or non-phosphate fixing system, flooding increased phosphorus availability, regardless of the criterion used to assess this.

SUMMARY AND CONCLUSION

The availabilities of calcium, aluminum, and iron phosphates to rice grown in flooded and nonflooded media which would not interact directly with the phosphate sources and which did not contain native phosphate was studied in sand-cation exchange resin-nutrient solution substrates. Plant tillering, dry matter yield, and the phosphorus yield of rice were all much greater when the substrate was flooded. The availabilities of the calcium, aluminum, and iron phosphates, as measured by the A-value, were much higher in the flooded cultures. Excellent recoveries of monocalcium phosphate were obtained, particularly under flooded conditions. The A-values measured from the aluminum and iron phosphates were compared with those obtained with monocalcium phosphate. Two hundred and fifty pounds of P_2O_5 as iron phosphate was equivalent to 83 lbs. as monocalcium phosphate under flooded conditions and 56 lbs. under nonflooded. With aluminum phosphate, 250 lbs. P_2O_5 gave the same A-Value as 56 and 34 lbs. of calcium phosphate under flooded and nonflooded conditions, respectively.

CASE REPORT: BALANTIDIOSIS IN PIGS 1/

G. GARCIA AND D. DE LEON

Balantidiosis in swine is prevalent in the Philippines. The causal organism is a ciliated protozoon, *Balantidium coli.* The parasite is relatively large, measuring 30 to 150 microns long and 25 to 120 microns wide. 2/ It is usually found in the colon.

The organisms do not generally cause any ill-effect in swine. However, in heavily parasitized animals especially among the young stock, colitis and severe diarrhea may ensue wth serious results.

The parasite is a public health problem as it also affects man. Infection is incidental and is common in persons working in close contact with swine.

This is a report on balantidiosis in 28 Duroc-Jersey pigs of the U.P. College of Agriculture swine herd. The history, symptoms, and lesions are noted and the treatment given are included.

HISTORY AND SYMPTOMS

The pigs belonged to three separate litters. Nine were about a month old and the rest, two months. Each litter and dam were confined in a concentrate provided with a feeding through pig brooder, and a hog run also of concrete. The pen of a litter adjoined that of the other. The pens were flushed with water twice a day before feeding. The floors were kept wet for sometime.

On June 10, 1959, scouring was reported in all sucklings. Although watery and yellowish, the feces was not fetid. The appetite and respiration of the sucklings appeared normal. No fever was noted; the body temperature fluctuated between 38.5 and 39.0°C.

Mixed sulfamethazine, sulfamerazine, and sulfaguanadine powder in drench was first tried. This was continued for two days. On the third day, after failure to obtain any improvement, the animals were placed on a wide-spectrum antibiotic therapy.

The condition, instead of abating, went from bad to worst. All sucklings at this time showed the effects of marked fluid imbalance: prostration, gauntness, and rough hair coat. The feces was more

1/ Central Experiment Station Contribution No. 2081.

2/ B. A. Morgan and P. A. Hawkins. Veterinary Protozoology. Burgess Publishing Co., Minneapolis, Minnesota, 1952.

watery and tinged with blood. Difficulty in breathing was observed in a number of animals. Some developed coprophagy.

On June 14, 2 one-month-old and 1 two-month-old pigs died.

LESIONS AND FECAL FINDINGS

No apparent changes were noted in the viscera except in the large gut and lungs. Multiple small abscessess and hemorrhages of varying sizes were found in the colon. The pendant portions of the apical and cardiac lobes of the lungs were congested and edematous.

Microscopic examination of fecal samples taken from the dead and from a few of the surviving pigs revealed the causal organism, *Balantidium coli.*

TREATMENT

The disease is obstinate and difficult to treat. In animals, medication is directed principally at removing the parasites from the guts. Enemas containing either gentian violet 3/ or iodine 4/ preparations are being used. Carbasome, 5/ an arsenical preparation, has been tried in man. In addition to the adoption of strict sanitary measures, adjuncts are given to restore fluid loss, strengthen resistance and prevent secondary infections.

In the present case, "Ganaseg" of the chemical formula 4, d'—Diasoaminodibenzamidine diaceturate, was used. The compound is reported to be effective against certain protozoa of the babesia and trypanosome groups and it was thought worthwhile trying it also on *Balantidium coli.*

A 10 per cent solution of the compound was prepared and administered intramuscularly, at the rate of 1 c.c. (100 mg.) each to one-month-old pigs. Twice the dose (200 mg.) was given to two-month-old pigs. A wide spectrum antibiotic, *per orem,* was also given together with skin application of white liniment. The animals were placed on dry quarters which were cleaned regularly.

The day after the administration of "Ganaseg", microscopic examinations of fecal samples of a few pigs from each of the three affected litters were made. No protozoon could be found. The same negative results were obtained on the second and up to the fifth day. Antibiotic and liniment therapy was discontinued on the fifth day when the animals appeared normal.

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CASE REPORT: TYROID HYPERPLASIA AND THE HAIRLESS PIG MALADY

J. A. EUSEBIO, A. B. LOPEZ
E. C. CRUZ, AND R. B. PUYAOAN

WITH TWO TEXT FIGURES

In 1955, when the World Health Organization determined which areas in Asia had a high incidence of goiter, the Philippines was among those reported to be highly goitrous, and deficient in iodine.

In a communication with the Food and Nutrition Research Center of the Philippines (1959), Acting Research Director Conrado R. Pascual mentioned the principal regions in the islands suspected endemic for goiter: ".....certain localities in Batangas province (and) towns in the foothills of Sierra Madre in Rizal province. Los Baños may not be an exception to these towns since it is not far from Batangas.

This micronutrient element is easily assimilated by plants which are later utilized by animals. When iodine present in the soil or water is insufficient, endemic goiter in man as well as in farm animals may occur. Maynard and Loosli (1956) advise the addition of iodine in rations of farm animals, primarily in areas where the soil and water and food crops are low in this trace element.

INCIDENCE OF THE HAIRLESS PIG MALADY

In October, 1959, in the Swine Division of the Department of Animal Husbandry, U.P. College of Agriculture, a three-year old Berkjala sow gave birth to nine dead pigs. The litter showed outstanding characteristics of hairlessness and were slighty bloated or edamatous with thickened skin and puffy neck. (fig. 1). The "hairless pig malady" has been shown by Hart and Steenbock (1918) to be occasioned by low iodine assimilation, which results in goitrous condition of the young. Low iodine assimilation interferes severely with fetal development during gestation.

The records showed that this litter, the second for the sow, was the offspring of a cross between a Duroc boar and a Berkjala

1/ Central Experiment Station Contribution No. 2082.

Fig. 1—*Hairless baby pigs in full term.*

sow. The first litter which was sired by a Berkshire boar was physically normal. The other litter in the Swine Division herd sired by the same Duroc boar were all normal.

DISTRIBUTIONS OF IODINE

It is seen from table 1 that there was no iodine in the presumed natural sources of this element, except in the soil in the pasture of the swine compound. Young *et al.* (1936) reported that the iodine content of water has been correlated with the incidence of goiter in many areas of the world. According to Orr and Leitch (1929), sea water itself is not particularly rich in this element. On the other hand, studies to correlate the total iodine content of the soil and the plant in New Zealand and England have been very successful (Underwood, 1956).

To compare the iodine contents of the thyroids of the normal and affected pigs, a normal pig was sacrificed. The iodine contents

were found to be 0.7153 and 0.1503 per cent, respectively (table 1). Underwood (1956) cited that a pig's thyroid with hyperplasia contains 0.11 per cent iodine on a dry basis. This corroborates the report of Andrew *et al.* (1948) who found that the hyperplastic thyroid contains an average of 0.126 per cent iodine. They further stated that normal pig glands should contain an average of 0.323 per cent iodine, and that when concentration falls below 0.1 per cent, hyperplastic changes are regularly found. In our report, the average iodine concentration of the blood of the sow was found to be 0.0149 gm./100 ml.

TABLE 1.—*Iodine distribution in the blood, thyroid, soil, and water.*

SOURCE	TRIAL I	TRIAL II	AVERAGE
Sow oxalated blood	0.0128	0.0170	0.0149
College drinking water	0	0	0
Sea water (Laguna de Bay)	0	0	0
SOURCE	TRIAL I	TRIAL II	AVERAGE
Thyroid of hairless litter	0.1463	0.1544	0.1503
Thyroid of normal pig	0.7152	—	0.7152a/
Soil	0.0123	0.0120	0.0122

a/ one trial

ANATOMICAL CHANGES

Andrew *et al.* (1948) reported that the height of the epithelial cells increases and the amount of stored colloid decreases as thyroxine activity is increased. Typical abnormal and normal glands are shown in figure 2.

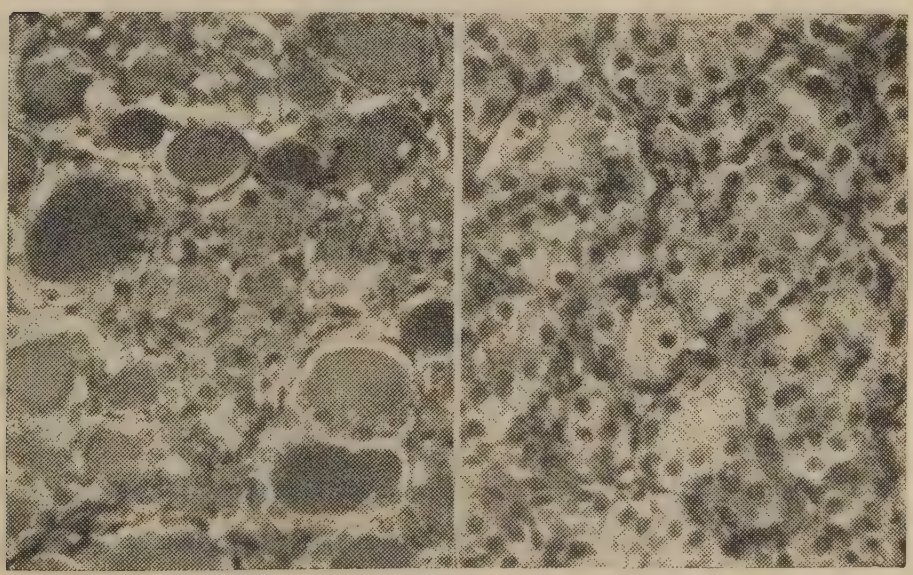

Fig. 2—*Left, abnormal thyroid gland; right normal thyroid gland* (x 250).

The gross anatomy of the normal and abnormal newborn pigs in this report was studied. The normal gland was slightly smaller, weighing 0.34 gm. whereas the abnormal glands showed no difference in size but weighed 0.482 and 0.717 gm. Andrew *et al.* (1948) further reported that there is a significant correlation of —0.35 between the iodine content and the thyroid weight in pigs.

CONCLUSION

The authors cannot draw a definite conclusion as to the actual cause of the malady. However, they feel that with these evidences, it is possible that this particular dam which farrowed to a litter of hairless pigs had been depleted of her stored iodine in the body during her second gestation period. This sow had been kept in close confinement during the gestation period, thus preventing her from using iodine from the pasture. Besides, the fish meal in the ration which was her only source of iodine, was slightly decreased because of its scarcity and the rise in prices of feedstuff. Gilbert (1957) noted that iodine is preferably taken into the body in the organic form.

To obtain further evidences, salt added with 0.05 per cent of potassium iodine was incorporated into the ration for pre-gestating sows. This level of iodine was based on the recommendations of Crampton (1956). No case of hairlessness was observed among newborn pigs.

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A PRELIMINARY STUDY OF STORED EXTENDED BOVINE AND BUBALINE SEMEN WITH KNOWN EXTENDERS AT REFRIGERATOR, JAR WATER AND ROOM TEMPERATURES 1/

L. L. CLAMOHOY AND O. A. PALAD

Under laboratory conditions, bovine and bubaline semen were diluted with known extenders such as 50 per cent yolk-citrate dihydrate, heated pasteurized skimmilk, Illini Variable Temperature (IVT) extenders, and Cornell University Extenders (CUE), and were stored at different temperature. The results indicated that IVT and CUE-extended bovine and bubaline semen could be stored for seven days in the refrigerator (5°C), four days in jar water, and two days at room temperature.

Field trials show high non-return rates for IVT and CUE-extended semen stored at refrigerator, jar water, and room temperatures.

To get a high rate of fertility through artificial insemination, the proper timing of insemination in relation to ovulation and the use of proper techniques of insemination as well as the use of semen samples of good quality should be considered. High quality samples could be obtained by storing the semen under optimum condition before it is used.

Extensive work has been done abroad, especially in the United States and Europe, on the storage of bovine semen in various extenders at various temperatures. Samples kept under refrigerated conditions (5°C) maintained good quality even after four days, and good breeding results have been obtained through their use. Furthermore, bovine semen has been frozen and stored at 79°C for months and even years without decreasing its fertilizing capacity.

The storage of bull semen at room temperature has also been studied both here and abroad. Recently, freeze-drying (lyophylizing) of bull semen, that is, preparing semen for storage in much the same way as antibiotics are prepared, was done, and it showed good promise of practical storage.

In the Philippines, refrigeration and freezing facilities, like cooling machines and dry and wet ice, are not extensively available. Rural areas could hardly be served with refrigerated or frozen semen without incurring much expense.

The most critical part in semen preservation is the storage tem-

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perature. Swanson and Herman (1941) first reported a satisfactory storage of bull semen in an ordinary household refrigerator with a temperature of 40°F (50°C). They noted that undiluted good quality semen stored at this temperature could be used for insemination with a reasonable degree of fertiliy within a storage period of two to three days. Glucose solutions and Milovanov's S-G-C-2 diluter did not increase the survival period of stored bull semen, but egg yolk-buffer diluter (Phillips and Lardy, 1940) was beneficial to the motility of bull spermatozoa for the first 100 hours of storage.

Foote and Bratten (1950) tried semen storage at 250°C with antibacterial agents in the diluters. After 24 hours, bacterial growth was inhibited, although motility was lower than 5°C.

With the addition of glycerol in semen exenders, the freezing of semen become possible as was demonstrated by Smith and Polge (1950). Much research has been done recently to determine the optimum conditions for freezing bovine semen.

VanDemark and Sharma (1957) reported on the dialysis method, a new technique of semen preservation at room temperature. The maximum sperm survival at temperatures ranging from 21 to 33°C was 7 to 15 days as compared to 4 to 6 days in control tubes. In their subsequent experiments with the Illini Variable Temperature extender, they reported comparable results from this extender and the standard yolk-citrate diluter.

Foote and Salisbury (1948) have shown that the motility of spermatozoa stored at 20°C in a citrate-phosphate buffer is prolonged by the addition of a number of antibacterial agents. Since egg yolk is an excellent medium for bacterial growth, one of the problems of preserving spermatozoa in egg yolk at room temperature appears to be that of controlling bacterial growth at this temperature.

VanDemark and Sharma (1957) reported that Illini Variable Exender (IVT) exended semen will maintain its fertilizing capacity for seven days at room temperature. Preliminary studies by Momongan *et al.* (1960) showed that under laboratory conditions,' IVT exended semen will store for four days under Los Baños conditions.

Foot *et al.* (1958) reported a new bovine semen extender with glycine and glucose, which they named Cornell University Extender (CUE). Fertility studies of the same was better than IVT under New York conditions.

The livability of spermatozoa in yolk-glucose-bicarbonate, as reported by Willett and Omhs (1956), is inferior to that in yolk-citrate. When spermatozoa was at a concenration of 15 X 106 per ml. in the former, it was equal to that in yolk citrate.

Earlier studies by Almquist *et al.* (1954) have shown that fresh homogenized milk and skimmilk can be used as satisfactory diluents for bovine semen, provided that milk is heated and cooled prior to semen dilution. Bolton and Durrell (1954), however, found heated skimmilk to be inferior to the egg-yolk citrate diluter.

In artificial breeding, the general practice is to preserve bovine spermatozoa in a buffered yolk-medium by cooling to approximately 5°C and holding the extended semen at that temperature until it is used. This procedure is based on considerable experimental evidences which have been reviewed by Anderson (1945), showing that spermatozao survive longer at 5°C than at higher temperatures.

This study was conducted in the Department of Animal Husbandry, U.P. College of Agriculture, from November, 1958 to December, 1960, to determine the effect of various temperature storages on the motility and fertilizing capacity of spermatozoa kept under known common and lately developed diluters for bull semen.

MATERIALS AND METHODS

Semen from 10 bulls of the Sta. Gertrudis, Sahiwal, Red Sindhi, Holstein, Grade Holstein, and Murrah buffalo breeds were used. The cows used for field trials were those of the dairy herd belonging to the College, and those of farmers within the pilot-breeding circuit maintained by the Artificial Insemination Center in College, Laguna, which includes the province of Laguna and the bordering portions of Batangas and Quezon provinces, and the Binalawan cattle ranch in Ilog, Negros Occidental.

The semen from the bulls were analyzed for their quality. Samples with 50 per cent initial motility or better were split and immediately extended with the following: (1) pasteurized heated separated milk, (2) 50 per cent yolk-citrate, (3) Illini Variable Temperature (IVT), and (4) Cornell University Extender (CUE). The composition of each extender is shown in table 1.

Final sperm concentration of extended semen was 25 X 10^6 motile sperms per cc. Antibiotics were added at the rate of 1000 units mcg. of penicillin and 1000 mcg. of streptomycin per cc. of extended semen.

The IVT and half of the CUE exended semen samples were ampuled and the rest of the treatments were kept in 10 cc. cork-stoppered tubes.

TABLE 1.—*Composition on a liter basis of the different extenders used*

INGREDIENTS	EXTENDERS			
	Y-C	IVTa/	CUEb/	Milk
Sodium citrate dihydrate, gm.	14.5	18.0	11.6	
Sodium bicarbonate, gm.		1.89	1.68	
Potassium chloride, gm.		.36	.32	
Glucose, gm.		2.7	2.4	
Glycine, gm.			7.49	
Sulfanilamide, gm.	3.0	2.7	2.4	
Heated Post. SM, cc.				1000
Egg yolk, cc.	500.0	100.0	200.0	

RESULTS AND DISCUSSION

Laboratory trials. In the premilinary trials, all the extenders tried were found to be good for at least four days at 5°C. However, only ampuled IVT and CUE extenders were practicable for jar water and room temperature shortages. Skimmilk and 50 per cent yolk-citrate extenders spoiled after 24 hours of storage. The encouraging results on IVT and CUE extended semen in jar water and room temperature storages led to a more comprehensive work along this line.

Table 2 shows the percentage of sperm motility of the experimental, or semen extended wih IVT, CUE and their modified forms, and of the control, or semen extended with 50 per cent yolk-citrate. The modified forms of IVT were done by adjusting the pH value of the extender using citric acid at the rate used for CUE. The modified form of CUE was prepared by adjusting the pH value and bubbling it CO2 gas with IVT.

The pooled average of all extenders under 5°C storage after four days increased motility by 10.8 per cent or 6.2 unit percentage, jar water by about 20.3 or 11.8 unit percentage, and room temperature by about 53. 7 per cent or 29 unit percentage. The decrease in motility was least with 5°C followed by jar water and room temperature. This condition remained until the 12th day of storage.

This shows further that jar water temperature can be used as a practical storage for exended bovine and bubaline semen much better than room temperature. The differences between than room temperatures were highly significant both at 5 and 1 per cent levels.

After four days of storage in the three temperatures, IVT and CUE extenders performed more or less similarly, although the for-

TABLE 2. — *Percentage of sperm motility of semen extended with IVT and CUE and their modified forms and 50 per cent yolk-citrate dihydrate (average of 10 bulls)*

Storage Temperature	Initial Motility	DAY 1						DAY 4					
		A	B	C	D	E	Ave.	A	B	C	D	E	Ave.
Jar Water	56	59	60	58	60	53	58.0	50	40	50	50	41	46.2
5°C	56	60	60	58	60	49	57.4	56	51	54	54	41	51.2
Room	56	48	60	58	60	46	54.0	21	31	32	18	23	25.0

Storage Temperature	Initial Motility	DAY 8						DAY 12					
		A	B	C	D	E	Ave.	A	B	C	D	E	Ave.
Jar Water	56	29	15	27	26	0	19.4	2	5	1	0	0	1.6
5°C	56	35	29	42	36	14	31.2	16	23	28	20	5	18.4
Room	56	2	6	7	5	6	5.2	0	0	0	0	0	0

Legend: A—IVT; B—Modified form of IVT; C—CUE; and D—Modified form of CUE; and E—5% yolk-citrate.

H.S.D. Among Temperatures ... 4.58 at 1% probability level; 3.54 at 5% probability level.

Among days, within extenders ... 6.89 at 1% probability level; 6.11 at 5% probability level.

mer was a little better. Their differences were statistically insignificant. Their modified IVT extender did not do as well as the modified CUE extender in both jar water and 5°C storages. At room temperature, the modified form of IVT extender was much better than the modified form of CUE. These remained the same until the 12th day of storage. However, the differences among the extenders storage temperatures were statistically insignificant.

The control (50 per cent yolk-citrate extended semen) was inferior to both IVT and CUE and to their modified forms at room, jar water, and refrigerator temperatures. Again, however, these differtenders within storage temperatures were statistically insignificant.

It also observed that 50 per cent of the motile sperms were samples of IVT and CUE on the second day of storage at room tem-

perature, which was a day shorter than the finding of Momongan *et al.* (1960), who reported 50 per cent motile sperms in IVT extended semen mostly from three to four days.

At room temperature storage, 3 out of 10 bulls maintained 50 per cent or more motile sperms at four days with IVT and 4 bulls with its modified form; 5 bulls out of 10 for CUE and 3 bulls with its modified form; and 3 bulls for 50 per cent yolk-citrate dihydrate.

At jar water temperature, 8 out of 10 bulls maintained 50 per cent or more motile sperms at four days for IVT and 6 bulls with its modified form, 7 bulls for CUE and 9 bulls with its modified form, and 5 bulls for 50 per cent yolk-citrate dihydrate.

At 5°C (refrigerator) temperature, all bulls maintained 50 per cent or more motile sperms within four days for IVT and 9 bulls with its modiifed form, 8 bulls with CUE and 9 bulls with its modified form, and 4 bulls for 50 per cent yolk-citrate dihydrate. At eight days of storage, however, 5 bulls maintained 50 per cent or more motile sperms for IVT and 2 with its modified form, 6 for CUE and its modified form, and none for 50 per cent yolk-citrate solution.

Storage of IVT and CUE extended semen was very handy at jar water and room temperatures when ampuled.

Table 3 shows the temperatures of jar water and the room during the experimental period, from March 23 to April 18, 1959 (dry season). The jar water temperature varied from 23.8°C to 25°C, or an average of 24.3°C. The room temperature varied from 26°C to 29°C or an average of 26.6°C. The difference between the jar water and room temperatures was significant.

Field trials. Table 4 shows the results of field trials conducted with IVT and CUE extended semen stored at room, jar water, and refrigerator temperatures.

Semen kept at room temperature was one to two days old when used. Of the 10 cows served with IVT extended semen, the 60 to 90-day non-return rate was 100 per cent, and of the 10 cows served with CUE xtended semen, one returned for reservice, resulting in a 60 to 90-day non-return rate of 90 per cent.

TABLE 3—*Room and jar temperatures during the period of experiment*

DATE	JW	RT
	°C	°C
3—23—59	24	27.5
24	23.8	26
25	24	26
26	25	27
27	24.5	26
28	24.5	27
29	23.5	27
30	23.5	25
	23.5	26
4— 1—29	23.5	26
2	24	26
3	24.5	26
4	24.5	27
5	24.5	27
6	24	26
7	24	26
8	25	27
9	24.5	26
10	25	27
11	24.5	26
12	25	29
13	25	27
14	25	27
15	25	28
16	25	28
17	24.5	26
18	24.5	27
Total	24.3	26.6
Average	358.3	719.5

H. S. D. Among Storage ..... .376 at 1 per cent probability level
.283 at 5 per cent probability level

TABLE 4.—*Rate of 60-90 day non-return of IVT and CUE extended semen stored at refrigerator (5°C) jar water and room temperature.*

	IVT			CUE		
Storage Temperature	Cows Insem-inated	Total Insemina-tions	60-90 day Non-Return Rate	Cows Insem-inated	Total Inseminations	60-90 Day Rate Non-Return
						per cent
5°C	35	41	82.8	35	38	91.4
Jar Water	18	21	83.3	16	18	87.5
Room	10	10	100.0	10	11	90.0
Total	63	72		61	67	
Average			85.7			90.1

Semen kept at jar water temperature was one to three days old when used. Of the 18 cows served with IVT extended semen, 3 returned, giving a 60 to 90 day non-return rate of 83.3 per cent. Of the 16 cows served with CUE extended semen, 2 returned, giving a 60 to 90-day non-return rate of 87.5 per cent.

Semen kept at refrigerator temperature was one to seven days old when used. Of the 35 cows served with IVT extended semen, 6 returned, giving a 60 to 90-day non-return rate of 82.8 per cent. Of the 35 cows served with CUE extended semen, 3 returned, giving a 60 to 90-day non-return rate of 91.4 per cent.

It was observed that for all storage temperatures, the breeding efficiency of two extenders were similar — 88.7 per cent for IVT and 89.9 per cent for CUE. IVT was better when stored at room temperature, but it was relatively inferior to CUE when stored at jar water and refrigerator temperatures.

Other observations based on breeding efficiency showed CUE to be a more stable extender than IVT. It was least affected by storage temperature. CUE-extended semen stored at jar water temperature was observed to be as that stored at refrigerator temperature until he fourth day.

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